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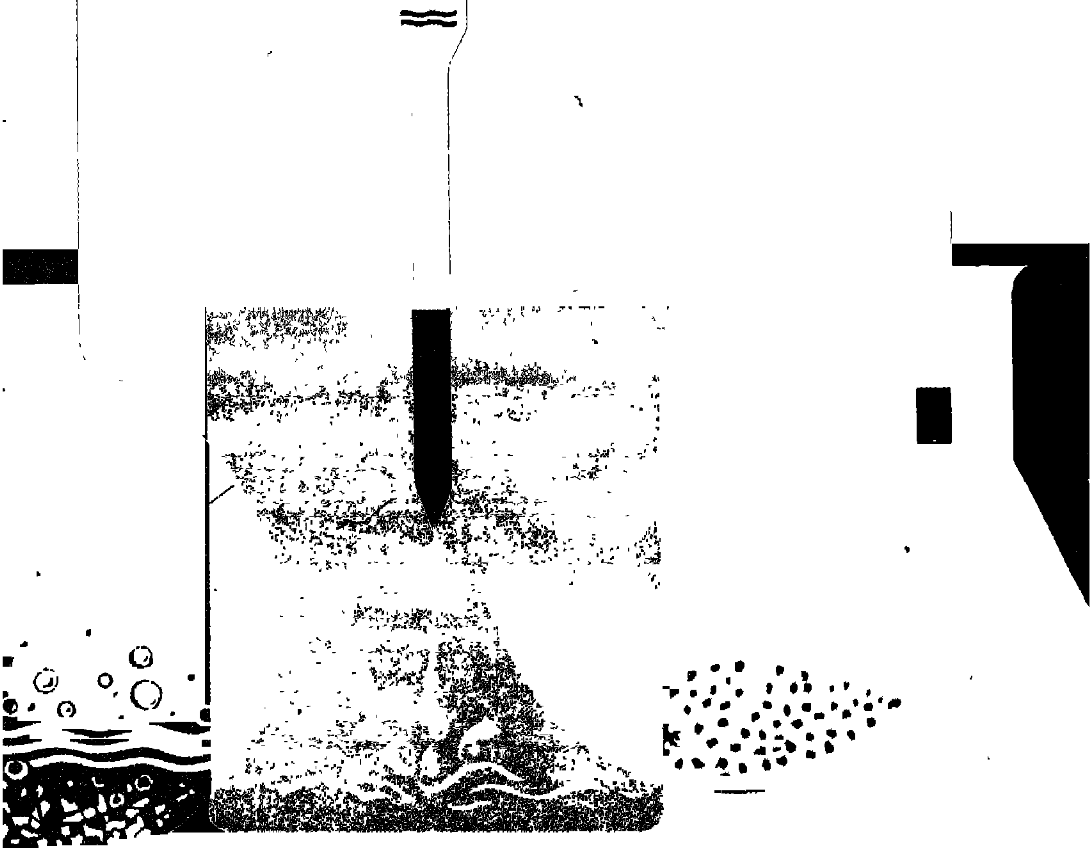

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NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

SCHOOL SCIENCE is a journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims at bringing within easy reach of teachers and students the recent developments in science and science methodology, and serves as a useful forum for the exchange of readers' views and experiences in science education and science projects.

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TO OUR CONTRIBUTORS

SCHOOL SCIENCE *invites articles from teachers, acquainting students with recent developments in science and science methodology. The articles should be addressed to the Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016*

Beyond White Dwarfs, Toward Black Holes

Prof. S. Chandrasekhar

An Introduction to S. Chandrasekhar

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S. Chandrasekhar was one of the most famous astrophysicists of the twentieth century. He is recognised as the founder of the black hole physics and the originator of the hypothesis of gravitational collapse. His scientific career spanned over a period of sixty-six years. It is distinguished by fundamental contributions to astrophysics, mathematical physics, plasma physics, general theory of relativity, science and aesthetics. The consistent high quality of the professional output, specially the enormous volume ot the scientific work of Professor Chandrasekhar, had his students and admirers in awe of the superhuman attributes endowed in him. On the contrary, S. Chandrasekhar, who was affectionately called Chandra by the scientific community, was down-to-earth in his approach and was a large-hearted teacher, who would go out of the way to encourage and help his students. He would invariably remind all those persons who had the good fortune to come near him that by sheer dint of consistent hard work together with disciplined work habits one can achieve highest peer recognitions without being a Dirac or a Heisenberg.

Multi-faceted Personality

It is not an easy task to write an essay that can bring out comprehensively the multifaceted personality of Chandrasekhar. Chandrasekhar can be viewed from various perspectives. It is fortunate that by focussing on narrow portions in the spectrum of his scientific contributions a glimpse of the exceptional mind can be seen.

At the age of nineteen, Chandrasekhar did his monumental work on the quantum

mathematical description of white dwarf stars. He revealed the possibility that massive stars towards the end of their life, because of the inward gravitational pull, can undergo unpreventable collapse and disappear into nothingness and thus become black holes. But, what is a black hole? A black hole is a region of space where the gravitational field is so strong that even light cannot escape out of it because of the strong gravitational pull. This type of a situation can be made plausible if we make use of the concept of escape velocity.

Theory of Escape Velocity

It is an everyday experience that when objects are thrown up from the surface of the earth they fall back. We are not surprised by such observations because Newton had explained that all objects are pulled by the gravitational force of the earth. It is also a common experience that faster an object is thrown up higher it goes before it falls back to the earth. The minimum speed with which objects if thrown up so that they do not fall back at all and may therefore appear to have escaped away from the earth to infinity is called the escape velocity at earth.

The mathematical expression for escape velocity from the surface of a spherical object of mass M and radius R can be obtained if we recall that the potential energy of an object of mass m at the surface of a massive object M is $-\frac{GMm}{R}$, where G= 6.672 x 10^{-11} $m^{3}kg^{-1}s^{-1}$ is the Newtonian gravitational constant. To overcome this amount of gravitational potential energy the minimum kinetic energy that the projectile must be given to enable it to escape to infinity can be determined by imposing the condition that at infinity the total energy, the sum of kinetic energy and potential energy, must be zero. That is

$$\frac{1}{2} m v^2 - \frac{GMm}{R} = 0, \quad \text{or} \quad v^2 = \frac{2GM}{R}.$$

This is the famous formula for the escape velocity. We next ask the question what should be the minimum radius R_s of an object enclosing the mass M so that the gravitational pull can be so strong that the escape velocity becomes equal to the speed of light c? This can be obtained by substituting c for v in the formula of the escape velocity.

$$c^2 = \frac{2GM}{R_s} \quad \text{or} \quad R_s = \frac{2GM}{c^2}$$

R_s is called the Schwarzschild radius of an object of mass M. We can easily estimate the numerical value of R_s for the sun and that of the earth by substituting for mass of the sun, M_O=1.988 x 10^{30} kg and for mass of the earth M_A = 5.983 x 10^{24} kg, and for the speed of light c =2.997 x 10^{8} m s^{-1} . The Schwarzschild radius of the sun is 2.953 km and that of the earth is 0.89 cm. The equatorial radius of the sun R_O = 6.959 x 10^{8} m. It is much bigger than its Schwarzschild radius, 2.953 km; and also the equatorial radius of the earth R_A = 6.38 x 10^{6} m is much bigger than its Schwarzschild radius, 0.89 cm. Light emitted at the surface of the sun reaches us and the earth is visible from the moon. The natural curiosity would be to know whether there exist objects in the universe whose outer surface is within their Schwarzschild radius? Such objects have been given the generic name black holes. Recent astronomical observations have revealed that there are a large number of strong candidates that fulfil the description of black holes.

White Dwarf Star

In 1929 When Chandrasekhar started his research studies on stellar structures the most massive and tiny objects known to astronomers were white dwarf stars. Arthur Eddington, the most famous astronomer and astrophysicist of all times, had first observed the enormous density of the tiny white dwarf star orbiting as a companion to Sirius — itself the brightest star in the heavens. Eddington pointed out that the white dwarf star is so dense that a ton of it would easily fit into a matchbox. White dwarf stars like Sirius B and 40 Eridani B have masses typically of the order of one solar mass, and radii of the order of 1/10 to 1/100 of the sun's radius. The Schwarzschild radius of these dense objects is well within their surface. They cannot be black holes. So, what is the connection of the Chandrasekhar's work on stability of white dwarfs with the hypothesis of gravitational collapse?

To fully understand the theoretical calculations made by Chandrasekhar which led him to the discovery of a fundamental mass expressible in terms of physical constants concepts both from classical and quantum physics are required. These concepts are :

1. equation of gravitational equilibrium of a star,
2. class of thermodynamical configurations called the polytropic equilibrium,
3. special theory of relativity and the Fermi-Dirac statistics.

The 19-year-old boy not only knew these concepts he could most effectively make use of them in working out the physics of white dwarfs and made his fundamental discovery. A mathematical description of this work is beyond the scope of this article and will not be attempted, What is being given in the article further is a qualitative description of the stability of stars based on Chandrasekhar's work.

According to Newton's universal law of gravitation an inward gravitational pull will be experienced in the presence of a spherical distribution of mass. But what prevents objects from being sucked inside by the gravitational force?

Objects like moon prevent themselves from this type of situation by revolving around so that the centrifugal force balances the inward gravitational pull. On the surface of cold and solid objects like the earth it is the elastic force that provides the normal force to balance the weight. However, in gaseous objects like stars such as the sun the gravitational pull is balanced by pressure due to kinetic motion of gaseous contents combined with radiation pressure. In stars due to thermo-nuclear processes energy is continuously generated. It provides pressure for the stability and is also radiated away from the surface enclosing the star. What happens to stars like sun when their fuel gets totally consumed by successive chain of thermo-nuclear processes? Stars at that stage undergo gravitational collapse till new types of physical processes provide the required pressure. It is now well understood that on account of intense rise in temperature due to release of gravitational potential energy when stars shrink the entire matter (hydrogen and other elements) inside gets totally ionised and a gas of electrons comes, into being. Electron gas then contributes the dominant part of the pressure. It was well understood by astrophysicists like A.S. Eddington and R.H. Fowler that the main sequence stars towards the end of their life achieve equilibrium due to electron pressure and settle down as white dwarfs. However, their calculations for working out pressure

used the approximation that electron gas can be treated by non-relativistic quantum statistics. Chandra-sekhar estimated that electron gas in white dwarf stars can be both degenerate and relativistic. He had learnt the physics of relativistic Fermi-Dirac statistics from the lectures given by A. Sommerfeld to the science students of the Presidency College, Madras in 1928. Chandrasekhar made the calculation of pressure due to relativistic and degenerate electron gas and studied the question of stability against gravitational force in objects like sun when they reach the white dwarf stage. Chandrasekhar's calculations revealed the existence of a fundamental limiting mass described by the following expression :

$$M_{cs} = \tfrac{1}{2}(3\pi)^{1/2}\,(2.01824)\left(\frac{\hbar^{3/2}c^{3/2}}{G^{3/2}m_n^2\mu^2}\right)$$
$$= 5.87\mu^2 m_{\odot}.$$

This expression which is completely given in terms of fundamental physical constants, Planck constant $\hbar$=2πh = 6.62 x 10^{-34} Js, speed of light c = 2.99 x 10^8 m s^{-1}, Newton's constant of gravitation G = 6.672 x 10^{-11} m^3 kg^{-1} s^{-1}, Mass of a nucleon m_n = 1.67 x 10^{-27} kg, and μ is average number of nucleons per electron, in matters like white dwarf $\pi \simeq 2$. The numerical value of M_{cs} can be calculated by substituting numbers for $\hbar$, c, G, m_n and μ. It is easily worked out that

$$M_{cs} \simeq 1.4\ M_{\odot}.$$

This mass is known by astronomers and astrophysicists throughout the world as the Chandrasekhar limit. It can also be easily checked that dimensions of the expression $\hbar^{1/2} c^{3/2}/(G^{3/2} m_n^2)$ are that of mass.

Chandrasekhar Limit

The significance of the Chandrasekhar limit is that if a star has mass less than this limit it can settle down for eternity as a white dwarf but if its mass is greater than this limit the electron pressure will not be sufficient to prevent further gravitational collapse. This discovery of Chandrasekhar was so revolutionary and startling that Eddington challenged the correctness of this work and asserted that there must be a more complicated sequence of thresholds determined by the complexity and quantum nature of events that can get around the Chandrasekhar's inevitability that stars with mass more than M_{cs} can eventually collapse to nothingness. It is now recognised that Eddington's strong personality and scientific stature retarded for about a quarter century further research in this field. In the history of science the confrontation between Chandrasekhar and Eddington has a special place.

Tribute to Chandrasekhar

Bernard Lovell in the obituary to S. Chandrasekhar in The *Guardian* (newspaper published from London, U.K.) of August 24, 1995 has beautifully described the events of that time. We reproduce Lovell's words :

> There are only a few epic confrontations in the history of astronomy and Chandrasekhar was involved in one of these 60 years ago. He had arrived in Cambridge in the autumn of 1930 as a 20-year-old post-graduate student. During the long voyage from India he had reached a remarkable conclusion about the final collapsed state of a massive star.

It was not a good time to arrive in Cambridge with iconoclastic views about stars. Eddington dominated astronomy and his influence was so great that no one seriously

questioned his views on the internal constitution of stars. The young Chandrasekhar did so and the conflict with Eddington erupted in public at a memorable meeting of the Royal Astronomical Society in January 1935. At that time the conventional opinion was that when a star had exhausted its energy- reproducing process it would collapse into a white drarf with its entire mass concentrated in a volume less that of the earth. Eddington maintained this was the only possible final state in which the nuclei of atoms were crushed almost in contact by the enormous force of the stellar collapse.

On that voyage from India Chandrasekhar concluded that this explanation could be given a more generalised form by applying the concepts of Einstein's special relativity theory. He reached the startling conclusion that there was a limit to the mass of a star which could collapse into a white dwarf. He believed that if a star was more massive than 1.4 times the mass of the sun it would collapse catastrophically beyond the white dwarf stage to states of incredibly high density. That was the origin of the modern concepts of neutron stars and black holes.

In that famous January 1935 meeting of the Royal Astronomical Society, Eddington ridiculed Chandrasekhar's ideas. He thought Chandrasekhar had made a fundamental error of principle and said, "I think there should be a law of nature to prevent a star from behaving in this absurd way." The young Chandrasekhar was humiliated and depressed, but he remained certain that his ideas were correct and sought the opinion of the great physicists whose concepts he had used. They agreed with him. But, such was Eddington's influence, not one of them was willing to enter the public dispute. It was a time when specialisation led to the belief that physics and astrophysics had little in common. Chandrasekhar's youthful work and all his subsequent career emphasised the falsity of this supposition.

Thirty-three years later the discovery of pulsars and the recognition that there were neutron stars produced the observational confirmation that Chandrasekhar's revolutionary ideas were correct.

We continue with the description of developments that followed Chandrasekhar's classic work. It was soon recognised that stars on collapse beyond the white dwarf size can reach another threshold where equilibrium is possible. Through radioactive process, commonly called beta-decay and inverse beta-decay, electrons and protons can combine to form neutrons. In such situations matter largely consists of neutrons and has properties of a giant nucleus. It may be possible for the pressure due to neutrons to balance the gravitational pull and for the star to reach equilibrium. The existence of such stars was predicted by Oppenheimer and his collaboraters in 1930 and were named neutron stars. However, these exotic objects remained a textbook curiosity until the 1960s, when radio and optial astronomers discovered in 1968 a pulsar at the centre of crab nebula in the Constellation of Taurus. Pulsars have since been identified as rotating neutron stars. The neutron stars also reach a maximum limit in mass for equilibrium, which is of the order of solar mass, and a radius of the order of 10 km.

The mental block for a star like the sun to shrink to a few kilometres was overcome with the discovery of neutron stars. The possibility of stars more massive than the Chandrasekhar limit collapsing into black holes when they are neither able to reach equilibrium as a white dwarf or as a neutron star became a likely possibility. The field of black holes has since been taken up for serious scientific studies by astronomers and by

Prof. Chandrasekhar with Shri Morarji Desai

physicists and astrophysicists alike. In 1960s Chandrasekhar himself revived his interest in the general theory of relativity and its application to astrophysics in general and black hole physics in particular. Chandrasekhar wrapped up his work on the stability of massive objects like stars in his seminal work called *The Mathematical Theory of Black Holes (1987)*. Though belated, in 1983 Chandrasekhar shared the Nobel Prize for his quantum mathematical prediction that large stars must undergo gravitational collapse as they burn out.

To conclude this article it would only be apt to recognise S. Chandrasekhar as a brilliant star without limit.

Problems in Reading in Mathematics

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There are problems in reading, unique to the academic area of mathematics. If a learner does not attain well, the problem may lie in the area of reading of subject matter. Sometimes teachers may confuse ability with experience. Thus if a pupil is not attaining as adequately as the teacher would wish, the mathematics teacher may speak of the pupil as lacking in ability. Rather than lacking in ability, the pupil may lack background experiences which hinder in mathematics achievement. A rich background of experiences can certainly aid the pupil in attaining more optimally. I recommend very strongly that teachers provide a variety of rich experiences so that the learner may acquire knowledge and skills, as well as quality attitudes. All pupils need to experience success in the mathematics curriculum so that a better self-concept evolves. Adequate background experiences should accrue so that improved reading in mathematics is an end result.

Improvement in Reading

Pupils do differ from each other in quality of reading exhibited in mathematics. Ideally, a learner should be able to read approximately 95-98 per cent of the running words encountered without any previous practice. As the learner pronounces fewer than 95 per cent of the running words correctly, comprehension will tend to go downhill. If more than 98 per cent of the running words are read correctly, recreational reading is in evidence. This kind of reading is good for leisure time reading, but not adequate for continued growth to occur in reading. Thus with an approximate 95 to 98 per cent of running words pronounced correctly without previous practice, there is room for growth in learning to identify additional new words. Those whose reading level, without previous practice, is below the 95 per cent of words pronounced correctly from the content contained in the reading selection may well need additional assistance. The assistance might come in the form of help given in pronouncing words correctly in mathematics. The teacher, another pupil, or a high school student who is a member of the Future Teacher's Association (FTA) may provide this assistance. This assistance can give the help need for the pupil to do well in mathematics. I would recommend here that a pupil be given a chance to pronounce an apparently unknown word correctly. I recommend that a learner be given about five seconds to determine the unknown word before the teacher or an aid pronounces that word. Pupils do need time to ascertain what an apparent unknown word is in terms of pronunciation. The teacher wants to develop independent readers of mathematics content.

For all pupils, the mathematics teacher

should identify unknown words and print these on the chalkboard clearly for learners to see. Undivided learner attention to these new words should assist pupils to recognize them when reading from the basal. The teacher needs to be certain here that pupils are on task and receive necessary definitions for understanding the meaning of these new words. Thus success in contextual reading may be possible for most learners. With this learning opportunity, pupils develop their reading vocabularies in mathematics to take care of the unknown words in the 95-98 running words category of words pronounced correctly without previous practice.

Should phonics be emphasized in the mathematics reading curriculum? I would answer with generally "no" it should not be. However, the teachable moment is there in which assisting a learner with a word in which an unknown consonant or vowel is in evidence may take seconds of a teacher's time to do a little bit of teaching in phonics to guide learners to read more proficiently in mathermatics. As a whole, phonics instruction belongs in the language arts areas. But, increased relationship among different curriculum areas is being emphasized in teaching-learning situations, such as reading across the different academic areas. Phonetic analysis is a part of the act of reading.

Reading Abstract Symbols in Mathematics

Starting with the kindergarten level and progressing sequentially through the ensuing school years, pupils need to read meaningfully numerals used in the basic four operations, the number names in word form, the abstract symbols for greater than and less than, parentheses and brackets used in mathematics, radius, diameter, and radius squared, among others. Reading of these abstract symbols presents a unique kind of reading peculiar to mathematics alone. Thus reading the set of counting numbers—1, 2, 3, 4,5, 6, 7.... represents skill in being able to read mathematics content and ideas. Or the operation of multiplication and addition that has the following expression: 3x7+5x4= indicates that reading is not always done in a left to right progression. Several of my teacher education students over the years have responded with 104 as being the correct answer to the above expression. A rule needs to be learned here in that operations pertaining to multiplication must be completed first prior to any operation in addition the correct answer would then be 89 instead of 104. If a parenthesis is in evidence, then the operation is performed first pertaining to what is expressed therein, such as 3x(7+5)x4 = . The answer here is 144. In many cases then in mathematics, one does not read from left to right in sequence. There are definite rules to follow in performing operations on numbers. As additional examples, notice the following whereby generally most would start the operations from the right and move to the left : 1 3 4

$$\begin{array}{r} 134 \\ \times\ 84 \\ \hline \\ \hline \end{array}$$

Mathematics teachers need to provide a variety of rich learning opportunities when pupils encounter objectives pertaining to abstract symbols. Concrete materials should be used to guide pupils in understanding abstract symbols, such as in using markers (sticks, pencils, and seeds, among others) to show meanings attached to the concept of addition—three pencils and four pencils are how many pencils all together? This could be shown also in the semiconcrete with pictures of three pencils and four pencils, among other illustrations. In the abstract, this would

read 3+4= . With the use of concrete and semiconcrete materials of instruction sequentially, learners tend to understand the abstract better in orde1 of learning activities applicable in teaching-learning situations. When viewing the number sentence 3+4=7. Primary grade pupils should read the contents as the teacher points to the words in a left to right sequence. Being able to read mathematics content with understanding is of utmost importance. Otherwise, a pupil might have wasted his/her time in reading subject matter.

A Mathematics Glossary

Pupils with teacher guidance should have ample opportunities to become independent in attaching meaning to words read. With the use of context clues, the learner may ascertain the identification and meaning of a word by noticing the surrounding words within the sentence. If a pupil, for example, does not identify and know the meaning of the underlined word, the rest of the words in that sentence might take care of the unknown: The word *pi* is pronounced the same way as the pie that you eat. *Pi* has a value of 3.1417. I truly believe that most pupils would be able to attach meaning to the Greek symbol "pi" in context in these two sentences. The teacher then needs to assist learners to use context clues in reading mathematics subject matter. The use of context clues is a powerful means of recognizing new words as well as determining their meanings.

I would suggest that teachers assist pupils to develop a mathematics glossary individually or within a committee. This activity indicates that pupils can be authors and be empowered with their very own writing. Arranging words alphabetically is involved here as well as the correct spelling of words. Relevant terms need to appear in the glossary. Definitions for each word must be clear. Examples may clarify meanings of mathematics terms sooner than definitions. It would be good to use each term in a sentence within a contextual situation. If a learner forgets the definition/use of a term, he/she may refer to the glossary. The glossary should be in loose-leaf form so that entries may be added as necessary. Pupils need to become independent in recognition of words and their respective meanings. It also saves the teacher's time when a pupil does not need assistance. The teacher might then provide help to those who need it to progress more sequentially. The mathematics glossary should assist pupils to become increasingly better readers than would otherwise be the case. Diagrams might be added to a term if this makes the meaning more clear and distinct. Mathematics does have its own unique vocabulary as well as words that intersect with other academic disciplines and yet the word may have a separate meaning pertaining to mathematics.

Pupils Write Their Own Problems

Some very successful classrooms in teaching of mathematics that I have observed stress pupils writing mathematics problems. There are learners who do an excellent job of writing mathematics problems. Numerous educators emphasize the importance of writing across the curriculum. When pupils are actively involved in writing in mathematics, increased skills in written work are then being emphasized. I copied down several word problems that pupils have written in observational visits made to diverse schools. These are following.

1. Al had three shirts and his parents bought him two more. How many shirts did Al then have? This problem was dic-

tated to the first grade teacher who in return wrote what was stated.

2. Tony's father had fifty-two dairy cows. Six were sold. How many were left? This problem was written by a third grader who lives in a rural area.
3. During vacation time, Mary's parents drove 612 kilometres the first day, 386 the second day, 456 the third day, and 511 the fourth day. How many kilometres were driven all together? This problem was written by a fifth grader pertaining to an imagined number of days driven.
4. Bill has a circular garden. If the radius is seven metres, what is the area of the garden? This problem was written by a sixth grade pupil.

Pupils can assist each other in proofing the final written product. Problems may be written individually or within a committee. If a pupil cannot spell words well, this should not hold back a learner from active participation in writing in mathematics. Learners should assist each other in correct spelling of words. Reading of problems written by learners can be very satisfying to many pupils. When proof reading is done, pupils tend to read critically and creatively with the intent of solving problems and that is to write clearly stated content. Pupils need to experience a variety of reading situations in mathematics. The teacher may present a mathematics situation and have learners write the problem and also solve it. A teacher had sixth grade pupils look at a cylinder, a large empty fruit container, and ask for the volume of this container in cubic centimetres. An example of the final written problem as provided by a committee was the following:

An empty fruit can is shaped like a cylinder and is 45 centimetres high. The radius of the base or circle is 10 centimetre. How many cubic centimetres does the can hold?

For early primary grade pupils, the teacher may write what learners have given pertaining to a mathematics situation. Thus if the teacher shows two spoons in a set followed by two more spoons in a second set, how many are there all together? I have observed pupils who provided the necessary information clearly to the teacher. The teacher printed in neat manuscript letters that which the learners had presented orally for the mathematics problem. The problem in its final form can be printed in large manuscript letters on suitable paper and put away for future reading by learners. Pupils tend to like to read that which was completed previously.

Diagnosis in Reading and Writing in Mathematics

The teacher needs to diagnose weaknesses that pupils exhibit in writing. The specifics diagnosed should then be remedied. Which errors may learners then make in written work?

1. Numerals that are reversed such as for 3, for 7, and for 2.
2. Words or sentence parts that are reversed such as "was" for "saw" or "He/she the numbers added" for "He/she added the numbers".
3. Improper agreement of subject and predicate in writing word problems such as "He ride the Picycle" instead of "He rides the bicycle".
4. Lack of proper arrangement of numeals for column addition such as the one's, ten's, and hundred's columns not being aligned appropriately, thus making for errors in adding.
5. Not copying a problem correctly from the basal text in order to solve it at the learner's desk.
6. Failure to rename the minuend in subtraction when compound subtraction is

being emphasized.

7. Incorrect regrouping in compound addition when any column has a value of ten or more.
8. Not identifying geometrical figures and shapes correctly so that areas and perimeter can be determined with the use of formulas.
9. Incorrect procedures used in the basic four operations.
10. A general lack of neatness which hinders in responding correctly in written work in mathematics.
11. Accuracy in written work not being in evidence.

There are many additional areas of diagnosis that can be mentioned here such as not writing the whole and counting numerals correctly; not using the commutative, associative, and distributive properties correctly in writing; being unable to regroup and rename in the basic four operations on number; not being able to count in writing by twos, threes, fives, and tens; not writing negative numerals correctly; and inability to attach meaning to content written.

The teacher of mathematics needs to observe daily work of learners carefully to notice errors made. Each error should be corrected unless it is minor in consequences. Accuracy, creativity, and interest are salient factors in reading and writing in the mathematics curriculum.

Diary Entries in Mathematics

Pupils individually or in committees may write diary entries pertaining to sequential days of instruction in mathematics. These entries might then be shared with others in the classroom setting. The following are examples of specific diary entries which are dated:

OCTOBER 10. We worked on multiplying a fraction by a fraction. This appeared meaningless until the teacher showed the meaning of 1/2 times 1/2 = 1/4. The teacher showed 1/2 of a circle. Then the 1/2 was divided into two equal parts to show the answer as being 1/4. Pupils were asked to think of how fractions can be used in everyday life. Everyone agreed that pies were divided into parts within a family and the portion size depended upon the number of family members. Then too, there are times when a part of the pie is left over for the next meal and needs to be divided among the number in the family whereby each may get a small slice indeed.

OCTOBER 11. The teacher guided the class to review selected operations on fractions that had been learned previously. Thus the teacher showed pupils a cardboard pie divided into five parts. Each part was a fifth of the pie. The fifths were added to show a value of one. So one pie divided into five parts is equivalent to five fifths. This was very clear when viewing the whole pie being divided into fifths. There would then be five equal parts.

OCTOBER 12. The teacher assisted us to understand that a mixed number can be changed to an improper fraction. If 1 and ½ circles are being considered, how many halves are there? The single circle was changed to 2/2's. Two halves and one-half can be seen as 3/2's with the use of the paper pie parts. The teacher assisted us to see practical application of division with fractions. Thus if there are five candy bars to divide among ten pupils, what fractional part does each receive? The actual candy bars or some other food items could actually be used to have learners attach meaning to the abstract fraction.

In addition to dairy entries, pupils individually or in committees may read and

write log entries. Logs cover a longer period of time as compared to diary entries. A log could cover one week's amount of time given to the teaching of mathematics. The diary entries might then be used to write the log. Thus a summary of what has been learned will accure. Logs are valuable to write due to the following :

1. Main ideas need to be written to summarize content.
2. Higher levels of cognition must be used by learners when writing main ideas which cover much content. For each day's recordings, one main idea should be adequate. A main idea may even summarize a week of school work in mathematics activities.
3. Specifics in written work may be stressed such as legibility in handwriting. Correct spelling of words, proper paragraphing, quality sequencing of ideas recorded, and neatness of the final product being in evidence.
4. Logs, as well as diary entries, may be saved for future reading by pupils.
5. Committee skills may be developed by learners if rules are developed prior to group endeavours. The rules need to be enforced.

The teacher should have pupils read and write for a variety of purposes in mathematics. Mathematics content is retained for a longer period of time if it is used such as in written work. Learners tend to forget that which is not or rarely used in everyday life. Pupils tend to remember what has been learned if it is used in diverse ways.

Reading and Writing Test Items

Pupils can use what has been learned through the reading and writing of test items in mathematics. Multiple choice test items might be written when pupils reveal readiness factors. Each multiple choice test item usually has a stem and four responses, one of which is correct. The stem together with each of the four responses should be grammatically correct. The following model of a multiple choice item may be used by pupils:

Which of the following shows the intersection of two or more circles?

(a) The formula for the area of a circle.
(b) Venn diagrams.
(c) The commutative properties.
(d) The property of closure.

Each response must be plausible in the multiple choice test item. For example, if Mickey Mouse had been listed as a response, the concept of being plausible would have been violated. I believe the above test item makes it so that learners need to differentiate each response. Pupils should learn to write test items in mathematics to be exchanged with others to notice achievement. Learnes need to be assisted to notice when trivia gets in the way of developing *quality* in test item writing.

Essay test items may be written by learners for others to respond to. Essay items need to be adequately delimited so that a general, clear-cut answer can come from the learner. The other extreme is to write the essay test item so that it is completely factual and involves little in terms of higher levels of thinking. Notice the following essay item which it too broadly stated: Discuss addition. This item is so broad that an entire book could be written on the concept of addition. It does not delimit what a pupil is to write about addition. The following is so delimited that a fact is wanted instead of a discussion: What is the answer to 269 plus 186? This number pair could be written in a computation section of the test. The following is adequately

delimited and permits higher levels of cognition: Discuss the differences in finding the area of a circle and the volume of a rectangular solid. Determine at least five differences.

Additional test items that learners may write in mathematics include matching, true, false, and completion. Peers may assist each other in proofing test items written. Improvement in clarity and meaning of each test item is vital. Improvement in reading and writing in mathematics is a salient end result.

Reading to Solve Word Problems

Word problems, also called story problems, in textbooks may provide selected difficulties to pupils. In solving word problems, a first step is that pupils comprehend the abstract symbols which make for words and sentences. Being able to read with meaning is a very first step in solving word problems. Second, pupils need to possess background experiences in solving these word problems. Background experiences provide readiness for problem solving in mathematics. Third, pupils need to understand what is being asked for in the word problem so that problem solving can come about. Fourth, learners need to view the problem in a holistic manner in that salient ideas are needed from the entire word problem in order that solutions may be found. Fifth, mathematical operations need to be performed to arrive at an answer. The answer should be perceived as being tentative, not an absolute. Sixth, the pupil needs to reflect upon the tentative solution(s). Thus the learner looks at weaknesses that might be inherent in the solution. Peer study of the tentative answer has many benefits. Pupils must be able to explain why they did what was done in securing the necessary answer.

Computer Use in Mathematics

Computer use should be an inherent part of learning opportunities for pupils so that objectives might be attained more effectively. Carefully selected programs which emphasize simulation may benefit learners much in the area of problem solving in mathematics. Tutorial programs can guide pupils to achieve new content sequentially in ongoing units of study. Drill and practice programs should assist learners to review what has been acquired previously. Diagnosis and remediation programs attempt to pinpoint that which has caused difficulties for learners in ongoing lessons and units of study. Remedial work should follow the point of diagnosis. Games in terms of mathematics programs provide enjoyment in mathematics as well as extend content studied previously. Each program should assist pupils to attain sequentially and meaningfully. Interest in learning mathematics is vital and salient.

When readiness is in evidence, pupils need to experience the use of the word processor in writing as well as in reading of subject matter in mathematics.

In Closing

Pupils need to experience a variety of reading activities in mathematics. There are commercially published materials for pupils to read. These should be on the understanding levels of individual learners. If the reading level therein is too complex, the pupil will not comprehend the contents. Feelings of frustration and failure may be an end result here. Should the commercial reading materials be too easy to read, boredom and a lack of challenge may enter in.

There are numerous opportunities to read what pupils have comprehended from a variety of concrete and semiconcrete ex-

periences and put in written form. Here reading and writing become one, not separate entities. What has been written may be saved for future reading by learners. Adequate background experiences assist pupils to be able to record ideas in written form. Learners need to practise the skill of reading so that it is continually refined. Mathematics has its very own terms that are unique to this academic discipline. It also has its own areas of concern, such as problem solving, which makes it imperative that learners learn to read mathematics content with meaning and understanding.

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The Power that Launched the Industrial Revolution

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WE LIVE in an era of rapidly accelerating industrialisation. The world has changed more in the past two hundred years than in the previous four thousand years; and it has changed more in the past fifty years than the previous one hundred fifty years! New forms of energy, communications, materials, etc. are being developed at a breath-taking pace. But what initially launched this massive revolution and gave it the vital momentum was a substance known to mankind from time immemorial (but not used), *Steam*.

Energy that Paved the Way

Before the industrial revolution that began about two hundred years ago, the most powerful tool in the hands of man was the horse or the bullock. But once the power of steam was recognised and harnessed the energy available to mankind increased several fold and also paved the way for the later development of other sources of energy like electricity, oil, nuclear power, etc.

Water, when it is heated, first reaches the temperature called the "saturation temperature". This is 100°C at sea level, but increases as the pressure is increased. For example, at a pressure of 5 bar (approximately five times the atmospheric pressure), the saturation temperature rises to 150° C. If it is heated further, water boils to form steam at the same temperature. If the steam is further heated, it becomes "superheated steam". Steam that is superheated under high pressure contains a high amount of energy.

The earliest recorded demonstration of the power of steam was by Hero of Alexandria, in the first century A.D. He admitted steam to a sphere free to rotate about a horizontal axis and containing two nozzles pointing in opposite directions. The kinetic energy of the steam leaving the nozzles made the sphere rotate rapidly. This is essentially the principle of the steam turbine. But the significance of this demonstration was not realised for several centuries.

Here it might be useful to digress a bit. Why were the scientific implications of this experiment not recognised in those days? It was not because the people of those days were less intelligent than the present ones; it was because they did not possess the *scientific temperament* of studying natural phenomena with an open mind. No nation can progress industrially unless the scientific temper is nurtured and encouraged by its education system.

It was only in the eighteenth century that the power of steam was finally put to use. Coal mines of those days were frequently flooded by subsoil water and had to be drained out. Thomas Newcomen (1663-1729) developed the first widely used steam powered water pump in 1712. It worked by moving up a piston in a cylinder by steam pressure and then bringing it down by con-

densing the steam through a spray of water. This reciprocating motion was made to operate a water pump.

Steam Power

James Watt (1736-1819) must be considered the father of Steam Power. In the 1760s, he introduced a scientific approach to its development. He first improved the Newcomen engine. He then succeeded in converting the reciprocating motion of the piston into a rotary motion by a crank and connecting rod mechanism. This made the steam engine applicable to purposes other than water pumping also. He also invented a governor mechanism to control the speed of the steam engine. (It is said that Watt realised the power of steam while watching a kettle lid being lifted by the steam formed inside. The story may be apocryphal, but it certainly illustrates what keen observation can lead to).

Subsequent developments in steam engines included the slide valve for controlling the steam flow into the cylinder and compounding of the engine into high pressure and low pressure stages. Steam engines launched the Industrial Revolution.

Arrival of Engines

Robert Stephenson (1781-1848) successfully used the steam engine to power a locomotive in the 1820s. The Age of Railways dawned, to change for ever human society. Apart from their economic effects, historians declare that the railways have played a vital part in holding together large nations like India and the USA during the critical periods of their nation formation.

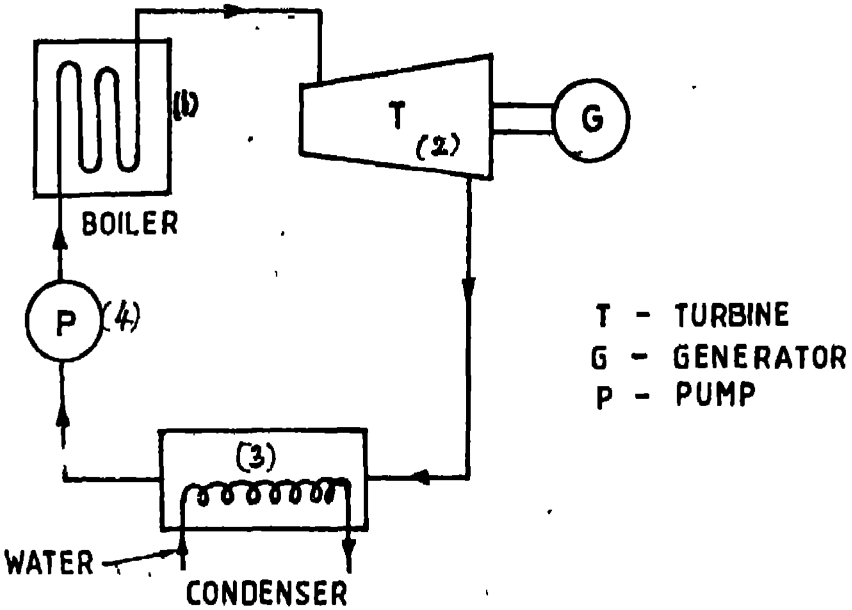
With further development, steam engines were used to drive electrical generators for large-scale electric power supply and also for powering ships (The Age of the Sailship, lasting more than a millennium, was thus brought to an abrupt end).

The later invention of the steam turbine gradually led to its supplanting the steam engine in power generation and marine propulsion. Steam turbines are more compact and efficient than steam engines. The pioneers in this field were Carl Gustav de Laval of Sweden and Charles A. Parsons of Britain, who developed in the 1880s, the impulse and reaction types of steam turbines respectively.

The fuels used for raising steam were initially wood and coal, but later petroleum (in the form of furnace oil) and natural gas also came into use. Nuclear reactors are also presently used, through the heat they generate, to raise steam for electric power production and marine propulsion.

The rapid development of technology in the twentieth century has led to the gradual replacement of steam by more efficient and more convenient sources of energy in many applications. Locomotives are today mainly powered by diesel engines. So are most ships. But there is one field in which steam power still reigns supreme and that is in electrical power generation. Modern industrial societies need enormous amounts of electrical energy for their functioning and it is mainly steam that is still supplying it to them. Coal, furnace oil, natural gas and nuclear energy are used to raise steam for power generation.

The steam power cycle used for electricity generation is shown schematically on page 17. Heat liberated by the combustion of one of the fuels already mentioned or nuclear reactions (in a nuclear power plant) is used to heat water, and convert it into superheated steam at high pressure. Modern boilers are capable of supplying steam at pressures as high as 250 atmospheres, at temperatures around 550° C. From the boiler (1), the steam flows to the steam turbine, (2), in



Schematic diagram of a steam power plant

which it is expanded in stages to a pressure below the atmospheric pressure. The outgoing steam goes to a condenser (3), where it is condensed to water by cooling. The condensed water is drawn off by a pump (4) and fed back to the boiler. The steam turbine is coupled to an electrical generator.

Multifarious Use of Energy

Single units of steam turbines as large as 1000 MW capacity are currently in use (enough to supply the electricity needed by a large city!). Modern steam power plants are incredibly complex and efficient. They use a variety of devices to extract the maximum possible work from the fuel burned. An efficient thermal plant converts about 40 per cent of the heat energy liberated by the combustion of the fuel into an equivalent amount of electrical energy. With the development of better materials of construction for boilers and steam turbines higher and higher steam pressures and temperatures are being used, leading to higher overall efficiency.

Alternative methods of generating electrical power like solar photovoltaic cells, wave and tidal energy, wind energy, etc. are being gradually developed, but it will be a long time, at least several decades, before they can possibly supplant steam power generation. Until then, this force of nature, the one that launched the industrial era and continues to sustain it, will serve mankind faithfully.

Study of Students' Difficulties in Understanding Calculations Involving the Mole

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A good understanding of the mole concept is very much essential for secondary school students as it links many aspects of modern chemistry. A few research studies support that mole concept is one of the difficult topics. A study was conducted to understand students' difficulties in solving problems related to mole. The current paper describes details of this study.

THE MOLE is an essential part of the modern approach to chemistry teaching because it acts as a unifying concept, linking many aspects of the subject. A study by Duncan (1974) among Scottish children investigated the nature of their learning difficulties on mole concept and suggested that many pupils have not attained the required level of understanding even at the age of 16. Shayer (1972) attributes the difficulties to the concept of proportion, an integral part of the mole concept while Ingle (1981) attributes the difficulty to mathematical steps involved in calculations. Since the difficulties experienced by the students on the mole concept are likely to affect proper learning of many other concepts at secondary school levels, it is proposed to assess secondary school students' knowledge on mole concept.

Methodology

The procedure used for the study includes free interviews, a questionnaire based enquiry followed by structured interviews. The first part of the study is aimed at enabling the students to express freely on the notion. The results of this part helped to draw up a questionnaire (see Appendix). The second set of interviews (structured interviews) were conducted to probe further for deeper understanding of students' concepts and was based on the analysis of the results of questionnaire-based enquiry. The students who participated in the study come from secondary schools located in different regions of Karnataka and Andhra Pradesh states. Some of these schools follow CBSE curriculum while the rest follow state curriculum. Based on the recommendation of the teacher high, medium and low achievers from each school were selected. These students were administered a test. No time limit for the completion of the test was imposed, but this was over within 15 minutes. The mean scores, standard deviation and t-values were computed. The signifi-

cance of t values were tested at 0.05 and 0.01 levels.

Results and Discussion

The results indicate that there is significant difference between the performance of CBSE and state curriculum students (t=5.91, significant at 0.01 level; df=183); boys and girls (t=2.54, significant at 0.05 level; df=183) and English and regional language medium (t=8.51, significant at 0.01 level; df=183) students. Significantly CBSE curriculum students, girls and English medium students have scored good marks. The facility value and discrimination index are also calculated (Table 1). These values reveal that questions

TABLE 1

Performance of Students on Test (N=185)

Question Number	*Number and % of successful students*	*Facility value*	*Discrimination index*
I	121 (65%)	0.65	0.62
II	110 (59%)	0.59	0.84
III	84 (45%)	0.45	0.58
IV	81 (44%)	0.44	0.80

III and IV are difficult while questions I and II are of medium difficult level. The discriminating indices indicate that only questions I and III are good at discriminating the strong and weak students. Based on students' responses for question I, it is clear that 35 per cent of the students do not know the relationship between the molecular weight of a compound and the number of particles (Avogadro's number) present in 1 mole of a substance. Example: 14 per cent of students in the sample have multiplied the molecular weight with Avogadro's number, 8 per cent of students divided Avogadro's number by 1.8 while 13 per cent of students admitted their lack of knowledge to calculate the molecular weight of water and do the mathematical calculation though they knew the number of particles present in 1 mole of water. The analysis of the responses for question II shows that 59 per cent of the students answered correctly while most of the remaining students went wrong in numerical calculation. For question III, majority of the students think that half of the Avogadro's number of particles are present in HCl gas. These students have the misapprehension that only Avogadro's number of particles of product (s) will form in all chemical reactions. Only 44 per cent of students have responed correctly for question IV. On probing further, students expressed their poor knowledge of the relationship between number of particles and gas volume. From the foregoing discussion, it appears that majority of the students have poor knowledge of the relationship between the following:

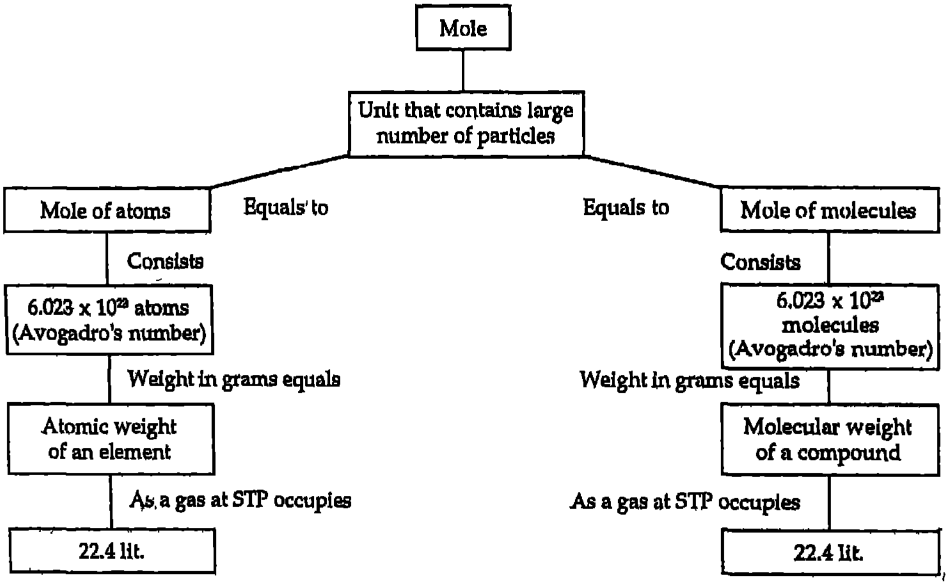
1. A mole of substance and atomic weight/ molecular weight.
2. A mole of atoms/molecules and Avogadro's number.
3. A mole of molecules and gas volume.
4. Avogadro's number of atoms/ molecules and atomic weight/ molecular weight.
5. A mole of atoms/molecules and atomic weight/molecular weight.

Implications for Teaching

A few workers have identified the areas of difficulty associated with the understanding of mole concept at secondary level. Head (1968) constructed a diagram to teach mole concept. This diagram demonstrates the relationship between three properties of substances namely number of particles contained in it, its weight in grams and its vol-

ume as a gas at STP corresponding to mole. Gower (1977) listed eight basic types of calculations involving the mole at 0 level course. Lazonby (1982) suggested a teaching order consisting of six steps to impart confidence and competence among students. Students should be exposed to different types of exercises so that they recognise how a mole of a substance is related to atomic weight or molecular weight or other concepts.

A simple flow diagram is given to illustrate these and a good understanding of this diagram enables the students to see straightaway the number and sequential steps required for doing stoichiometric calculations.



Flow Diagram

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APPENDIX

I. Gram molecular weight of water contains Avogadro's number of molecules. 1.8g of water contains ______ number of molecules.

II. One mole of nitrogen equals to 14g. 0.5 mole of nitrogen contains ______ number of molecules.

III. One mole of hydrogen gas combines with one mole of chlorine gas to yield two moles of hydrogen chloride gas. One mole of hydrogen chloride gas contains ______ number of molecules.

IV. 8g of oxygen occupies 11.2 lit volume at STP. The volume occupied by 0.6023×10^{23} molecules of oxygen is equal to ______

Science, Religion and Superstitions

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On the name of superstitions, not millions but billions of people become frenzy in many parts of the world. India is not an exception, which is an epicentre of many religions, faiths and beliefs. The inculcation of scientific attitude is the need of the day to avoid misconception in countries where poverty-trodden society is struggling for survival and such countries are India, China, Bangladesh, Pakistan, Thailand and many countries of Africa and some of the countries of European contingent as well. Copernicus was sentenced to death because he proposed a heleocentric structure of solar system, Galileo was also sentenced to death as he told that earth revolves around the sun. Becon was sentenced for 14 years and Lavoiser was glutonised for disclosing the secret of the nature.

With the advent of new horizon of science and technologies, the 19th century has become a landmark as most of the countries have come out from the clutches of superstitions but India is still dependent on the mercy of "Indra Devata" for agriculture and "Surya Devata" for avoiding flood. When we fail in our task due to half-hearted efforts, we attribute our failures to these superstitions.

In the field of agriculture, telecommunication, transport, medical sciences, entertainment and industries, many countries like America, Canada, Japan, Switzerland and countries of erstwhile U.S.S.R. have progressed by leaps and bounds. They have shaken off most of the superstitions. If India wants to come out from the grip of ignorance, we have to develop scientific attitude without hurting the feelings of religion and sentiments. In order to do so, we have a long chain of scientists and teachers who are to be trained in such a way that they may be able to eradicate irrational beliefs which lead to check the growth of country. In India, ignorance, illiteracy and lack of scientific knowledge are the most important thrust areas to be stressed. We have to accept it as a challenge as India has a very ancient civilization which was developed in thousands of years. There are 18 national languages and 1652 dialects with 8 religions. The Hindu, Sikh, Buddha and Jain religions got birth here and Christian, Mohammedan, Bahai and Parsi religions are being nurtured here. In such a composite culture due to unity in diversity and diversity in unity, it is imperative to have many myths, superstitions and beliefs.

There is enough scope to work on superstitions. The educationists, scientists and teachers have to develop special methods to combat superstitions. What is the basis if a cat crosses the path? One-eyed man is seen at first sight? Milk or white material is seen at first? Not to go according to *Dishashul* on journey? Not to purchase or touch iron on Saturdays? Not to cut nails on Thursdays? To start worshipping to avoid owl-hootings or dog's hawl, washerman's donkey or newly married woman as a good luck sign? Widow

as a curse? Deadly fatal viral pox due to anger of the goddess? Leprosy as consequences of sin? *Yogya* to avoid bad effects of Rahu and Ketu on eclipses? The scientific awareness and scientific attitude is need of the country to avoid such foolish beliefs, which may hamper the growth of the nation. Scientific phenomeas of many kinds may change into miracles. Recently, Lord Ganesha's drinking milk phenomenon, which is well known fact of surface-tension, siphoning and capillary mechanism within spur of moments, changed into a miracle. Prior to this few years back, "Insects leaf eating process" on lupha leaves changed into miracle of photographs of *Nag Devta* and *Nag Devi.* A decade back, when Skylab was to come on earth, Indians were more frenzy than in any other part of the world. The solar eclipse has changed to bad effect of demons Rahu and Ketu, though millions of people from India and abroad witnessed a rare phenomenon of total solar eclipse on October 24, 1995 which was seen after 360 years. On one side, scientists were observing rare total solar eclipse with a rare diamond ring with enthusiasm and zeal, while on the other side in Kurkukshetra, millions of people were worshipping sun to save it from bad and evil effects of devils Rahu and Ketu. Some were worshipping Lord Krishna who made sun to set before setting time in Mahabharata.

Even developed countries are not exception to this as some Eskimo tribes place their utensils upside down, Chinese ring bells, Shintos in Japan wear talisman, Red Indians think sun's fire being extinguished, people of Thailand pay offerings to Rahu and Cambodians worship. These are certain perceptions about solar eclipse.

Objectives

The objectives of the present investigations are :

1. To study the influence of religion on science teachers.
2. To compare the attitude of science teachers towards superstitions.
3. To compare superstitions in rural and urban areas.
4. To compare superstitions in educated and illiterate mass.

Sampling

The sampling was made in India at the time of rumour that Lords Genesha and Shankar are drinking milk from 21 September 1995 to 22 October 1996 when total solar eclipse was to occur and seen in various parts of India. The questions were administered to 50 odd science teachers from rural and urban areas. The test regarding milk was administered to 72 mixed lot of educated, uneducated with rural and urban background while for solar eclipse, telephonic poll of *The Times of India* was considered for testing superstitions.

Hypotheses

The following hypotheses were formulated and tested:

1. There is no significant influence on science teachers of religion.
2. There is negative attitude of science teachers towards superstitions in India.
3. There is more superstitions in rural area than urban area.
4. There may be no superstitions in educated mass in comparison to illiterate mass.

Background of Science, Religion and Superstitions

Science is a systematic knowledge and study of facts through experiments to find out the truth. Religion is a two-tier discipline of external part—ceremonial, ***shariyat*** or

karmkand and another to inner dispute/or the spiritual part. The inner discipline or spiritual part is an integrated phenomenon of all the religions and is based on moral universalism. Superstition is a belief which is not based on reasons or facts. People may get confused by blaming religion for superstitions or by assuming science as a answer to superstitions. The main factors responsible for superstitions are ignorance, illiteracy and lack of facts behind the matter. The *karmkand, shariyat* or ceremonial part of any religion is as old as religions and these traditions, rituals and customs were updated at the time of origin of religions. Most of the religions are 1000 years or older than this. In the climatic condition, food habits, environment and availability of matter, what was right in that period may not be true for this period. But if we want to perform that ceremony in the same way due to blind faith, it leads to superstitions. As human value changes from time to time, customs and traditions should also be the order of the day in the most comfortable ways. Myths, superstitions and facts go simultaneously with religion but we have to separate them to search out the truth.

The ultimate aim of both science and religion are to search out the truth. There is a difference somewhere in the ways of fact finding. In religion, only ceremonial part is the root of myths, beliefs and superstitions, which was not changed by fundamentalists for their own selfishness. Science and religion both were started from insightfulness and initially scientists and religious people gave various hypotheses, some of them proved correct and some incorrect in due course of time.

Many facts of science and medicine given in ancient *Vedas, Charak Sanhita* and *Gita* are still true today. Due to ignorance, lack of knowledge and different misinterpretation changed them to the stage of superstitions. Still it is difficult to speculate that which myth may lead to a fact or which fact may lead to a myth in the course of action and time. Maharishi Kanad and philosopher D. Avagodro both gave hypotheses about atom and molecules. Both the hypotheses now are partially correct as atom is divisible and destructible which could happen possible due to advancement of science. If earlier they would have invented electron microscope and diffraction methods, they would have searched out the truth in their time period. What I want to bring out is that many facts of science are relative truths in the present context. They may prove to be incorrect with the advent of science. The idea to go on moon or fly like birds come from fictions and legends. The father of genetics, Gregor John Mendel was the father in a church.

Though we have discovered many truths about atom but mystery remains there? Have you seen an atom or a molecule physically? Or do you know all the secrets of atoms? Scientists and sages both have tried to search out the mystery of existence of life, existence of nature and spiritual power that runs the nature. Is there any limit of elements? Is there any limit of mystery of atom? Scientists A. Einstein, I Newton, A. Lavoiser, Michael Faraday, Archimedes, etc. gave many hypotheses, out of which some proved to be false and some wrong in the future. As scientists think and speculate through experiments on available sources, sages or religious authorities also searched out the truth through meditation, insightfulness and their own experiments. One must confess that ignorance and lack of knowledge leads to superstitions and for this, blame should not come on science as a baseless study or man-

made drama or religion as a hypocrisy in the name of God. Certain Pandits, Maulavis and Fathers may misguide you or befool you but not all. We must remember "You can fool some people sometime, you can fool a few people all the time but you cannot fool all the people all the time". The education should be to free us from dogmas and superstitions.

Procedure

1. To know about influence of religion, science teachers were asked to answer the simple questions whether they believe in God or not irrespective of their religion. For this, 40 science teachers from cities and villages were asked for faith in God and on superstitions.
2. To know about relationship between science teachers and superstitions, 50 odd teachers were administered over opinion about superstitions and causes. Teachers were from villages and cities who are teaching science in schools.

TABLE 1

Science Teachers and Religion
(80 odd science teachers interviewed : 40 from rural and 40 from urban background)

Sl. No.	*Rural/Urban Science Teachers*	*Faith in God No faith in God and Religion* No.	%	*No faithin God and Religion* No.	%
1.	Science Teachers from Rural Area	26	52	14	28
2.	Science Teachers from Urban Area	22	44	18	36

TABLE 2

On Superstitions : Opinion of Science Teachers
(100 odd science teachers interviewed : 50 from rural and 50 from urban area)

Sl. No.	*Rural/Urban Science Teachers*	*Opinion on Superstitions*					
		Due to lack of understanding religion		*Due to lack of science knowledge*		*Due to ignornnce and illiteracy*	
		No.	%	No.	%	No	%
1.	Science Teachers of villages and Towns (Rural)	32	64	10	20	08	16
2.	Science Teachers of Cities (Urban)	18	26	20	40	12	24

TABLE 3

Superstitions about Milk Phenomenon (Drinking of Milk by Lord Ganesha and Shiva)
(Survey administered to 90 urban odd people and 72 rural odd people)

Sl. No.	Rural/Urban People	Opinion on Lord Ganesha Drinking Milk		Percentage of superstitious people
		Godly phenomenon	Scientific phenomenon	
1.	Rural people	62	10	81.9
2.	Urban people	51	39	76.4

TABLE 4

Superstitions about Solar Eclipse
(This secondary data is taken from the *Times of India* dated October 22, 1995)

Two questions were administered to over 323 persons of Delhi through telephonic poll between 16 and 19 October 1995

Q. 1.	Do you plan to stay indoors and avoid food during eclipse or will you follow your usual routine?		
	Response plan to stay indoors	:	68%
	Follow up usual routines	:	32%
Q. 2.	A solar eclipse is a malefic event; by prayers and *puja* one can protect oneself from harm?		
	Response of disagree	:	62%
	Response of agree	:	37%
	Response of can't say	:	01%
Q. 3.	Is it an age-old belief and practices must have a sound basis?		
	Response in favour	:	59%
Q. 4.	Is it a blind superstition?		
	Response in favour	:	41%

Conclusions

1. In India, there are quite a few science teachers who are atheists.
2. Unanimously, they accept that science has revolutionized in the field of communication, transport, medical science, agariculture and comforts but most of them have firm belief in supernatural power of omniscient, omnipresent, endless, formless sustainer of all lives and almighty who is controlling this entire world.
3. Science teachers have a positive attitude to talk about eradication of superstitions but due to taboos, faith and belief and not to hurt the feelings of masses, they do not come forward to control or to avoid panic of superstitions. Due to lack of proper training and lack of experimentation, they half-heartedly control the dogmas and myths.
4. The rumours about hoax and miracles of superstitions spread like wind and even now more than 50% science teachers are in the grip of hoax makers. The major causes are high rate of illiteracy and ignorance. Another reason is lack of knowledge of science.

5. Though science has been able to change mental outlook but due to deep-rooted religion, they are still trapped by magicians, sadhus, astrologers, pandits, mullas and fortune-tellers. The educated mass is not ready to condemn superstitions due to fear of God.
6. Superstition is prevailing more in villages and towns.
7. Superstition is coming down with the advent of scientific and technological progress but at a very slow rate. It has deep roots in rural areas in comparison to cities.
8. Students of science still believe in superstitions which is due to lack of scientific attitude and temperament of teachers. The teachers of science in India are still using rote memory concept and chalk and talk methods instead of fully equipped laboratory facilities.

Suggestions

1. Science teachers should be trained with scientific attitude in order to develop scientific environment.
2. There should be curricular programmes for eradicating superstitions.
3. There should be more stress on practica work in science subjects in compariso to theory.
4. There should be investigation o miracles, magic and superstitions to tel the truth.
5. Campaign against illiteracy should b continued by the government as well a social workers.
6. More science centres and science club should be opened for popularising sci ence.
7. Study of science and its methods to com bat superstitions is not enough. It shoul be stressed.
8. There should be regular study on na tional loss due to superstitions, myth beliefs and dogmas to know ignoranc in the mind of people from time to tim
9. Magic shows should be shown with ob jectives of eradicating superstitions an not as an art or trick or money-makin profession.
10. Media should play responsible role in th coverage of science to dispel blind b liefs in superstitions.

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Superconductivity

A Wonderful Discovery in Science

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Do you know that when electricity is transmitted from one place to another, the conducting wires are heated up and about 20-30 per cent of electrical energy passing through them is lost during transition in the form of heat? This is due to the resistance of the conductor carrying electric current. It is worth noting here, that if no energy is lost during transmission, the electricity which is being generated today in our country would be sufficient to overcome our present shortage of electricity. How would it be if the crores of units of electricity being lost during the conduction, were saved from going waste? Is it possible to discover such conductros in which no electricity is lost. In other words, discovery of some substance which offer no resistance in the flow of electric current through them?

Yes, scientists have discovered such a wonderful substance. For the last eight decades, the scientists all over the world have been working to discover such substances, through which electric current could be passed without any loss of energy, i.e. whose resistance is zero, and which are light in weight and cheaper than the conventional conductors. Such substances are known as super conductors, and the state of negligible resistance of conductors for the flow of electric current through them is known as *Superconductivity*.

It has been observed that the electrical resistance of the metallic conductors like silver, copper, brass, aluminium, etc. depend on temperature. With the decrease in their temperature, their resistance decreases. At a certain temperature, called *critical temperature or transition temperature* (TC), the resistance of the conductor becomes zero, and it starts behaving as a superconductor. For example, at 43K copper loses its resistance and becomes a superconductor. Therefore, the critical temperature for copper is 43K. Similarly, the critical temperatures of tin, lead, and mercury are 3.8 K, 4.7 K and 7.2 K respectively and, thus, at these temperatures these metals behave as a superconductor. Till now, the property of superconductivity has been observed in a few substances at temperatures much lower than zero degree celcius which is the limitation of using them practically at room temperature. However, throughout the world, efforts are being made to obtain superconductors at normal room temperature. The day when this becomes possible, a great revolution would take place in the world of science.

History of Superconductivity

For the layman, superconductivity may be a new thing, but for the scientists it is not a strange or new thing. They have been familiar with superconductivity for the last 85 years. In 1911, a Dutch scientist Kammerling Heike Onnes for the first time

discovered that by decreasing their temperature, the conductors could be converted into the superconductors. Earlier in 1908, he had succeeded in liquefying Helium gas at a temperature of -269°C (or 4 K). When he passed electric current through mercury placed inside liquid helium, he found that the resistance of the mercury suddenly disappeared and it started behaving as a superconductor. His discovery of superconductivity was appreciated throughout the world and for this, he was honoured in 1913, with Nobel Prize in physics, the highest honour in the field of science.

Discovery of High Critical Temperature

Since the time of discovery of superconductivity in 1911, the scientists have been working continuously to discover such substances which show superconductivity at the highest possible critical temperature. Till now, more than one thousand superconducting substances have been discovered but they show superconductivity at very low temperatures only. Nevertheless, in the race of finding superconducting materials with higher critical temperature, the scientists have started experimenting on mixed metals (or alloys). In 1941, the critical temperature of a mixed metal made of Niobium-nitrate was found to be 15 K. In 1973, another mixed metal of Germanium and Niobium was prepared whose critical temperature was slightly higher which was 23.3 K.

Uptill 1986 the highest value of critical temperature remained only 23.3 K. Seeing this hopeless rate of development, scientists began to think that it was impossible to discover high temperature superconductors. But suddenly, in January 1986, the ice was broken by a revolutionizing discovery when Alex Muler (60 years old) and Bednorze (37 years old) working in J.B.M. Laboratory, Zurich, Switzerland prepared a ceramic material whose critical temperature was 35 K. This substance was a mixed oxide of lenthanum, barium and copper. The scientists working in other laboratories of the world also verified this great discovery.

Within only one year of discovery, the scientists made a very long jump in this field. In March 1987, a scientist, Chingwuchu and his associates in Houston University prepared an oxide of yitrium-barium and copper whose critical temperature was 98 K. This brought superconductors within the range of practical application because the cheaper and easily available liquid nitrogen could now easily be employed to maintain the superconductors at the desired temperature. Since then, work in the field of superconductivity is in progress in almost all laboratories in the world.

Recently in July 1994, the scientists under the leadership of Michel Lague at National Centre for Scientific Research (CNRS) in France have developed a ceramic substance whose critical temperature is comparatively much higher, which is 250 K.

Physicists from the Centre for Research on very low temperatures and the Laboratory for Crystallography, Grenoble have reported that with compounds of cuprate family exhibited a drop in electrical resistance, partial or total, around 250 K.

Some scientists have got partial success in developing superconductors having critical temperature equivalent to normal room temperature. Unfortunately, the life span of such substance is very small. Scientists from Japan claim that they have succeeded in developing superconductors at 14°C critical temperature. Since this discovery is very important from both social and economic points of view, most countries tend to keep such discoveries secret.

Nobel Prizes for the Discovery of Superconductivity

Since the first Nobel Prize for superconductivity was given to Onnes in 1913, this prestigious award has been given to nine scientists for the research in superconductivity or in the related areas. This shows how important the discovery of superconductivity is!

In 1957, J. Burden, L.N. Cooper and J.R. Schriffer, on the basis of electronic and atomic explanation described the phenomenon of superconductivity satisfactorily by using the concept of electron-phonon interaction. After their name this theory is called as BCS theory. For this, in 1972 they were honoured with Nobel Prize.

In 1987, the Nobel Prize again went in the name of superconductivity to Mullar and Bednorge. Their work was unique and important in the sense that they discovered a new ceramic substance which was different from the all previous discoveries. This opened a new vista for other scientists and revived their hope to prepare superconductors at normal room temperature.

Theory of Superconductivity

According to the BCS theory, when an electron passes through an elastic crystal lattice, it causes a slight distortion in the lattice. This happens due to electron-phonon interaction. If this distortion retains for a certain duration, it affects the other passing electrons also. In 1956, Cooper said that due to this effect the electric current in the superconductors is not due to individual electrons but it is due to a bonded pair of electrons. These electron pairs are known as Cooper pairs. In fact, BCS theory is based on such a wave function in which all the electrons are paired on such a wave function in which all the electrons are paired due to the interaction between an electron of Cooper pair and a phonon, the total momentum of Cooper pair remains unchanged. Therefore, the flow of electrons continues with a constant speed for an infinite time.

However, the BCS theory does not apply for those superconductors which work at high temperatures beyond 40 degree kelvin. This theory is valid for those superconductors which work near 0K temperature only. About 10 to 15 theories have since been proposed to explain hot superconductivity based on the pairing behaviour of electron to a novel mediator. However, no complete theory has been developed so far, which could explain the superconductivity at high temperatures. It is very important to notice that there are a few metals like the niobium-tin mixed metal which act as a superconductor at high temperature of 180 K,however, if it is cooled up to the temperature of liquid helium, the level of its superconductivity is increased very much.

The idea that superconductivity is due to direct interaction between electrons came first from two Indian scientists, S.N. Ekbote and A.V. Narlikar of National Physical Laboratory, New Delhi, way back in 1980. On the basis of their theory, which was then not accepted, they could explain several aspects of superconductivity not explained by BCS theory. Now it is hoped to explain the origin of superconductivity in depth.

Meissner Effect

In 1933, Meissner and Ochsenfeld found that if a superconductor is cooled in a magnetic field to below the transition temperature, then at the transition the magnetic lines of force are pushed out. This phenomenon after the name of its discoverer is called the Meissner effect. In other words if a superconductor is placed in a magnetic

field the magnetic flux lines do not enter into it, they pass through outsides of the superconductor.

Uses of Superconductors

You have seen how much work is being done in the field of superconductivity, throughout the world. Nine scientists have been awarded with Nobel Prize for a single field. All over the world, there is a great race to develop superconductors at room temperature. It seems to be very important for scientists, but now the question arises how is it important for you, me, society, nation or world. Of course, on getting superconductors at normal room temperatures, an industrial revolution may begin in the world. Superconductor may play a very important role in the field of scientific research, new invention in engineering, in developing new processes and methods for computers and in the field of electronics, in developing high quality magnetic fields, or super-magnets and in medical science, etc. Some important applications of superconductors are discussed below.

For Electricity Transmission

If the wires conducting electricity are made of superconducting material, there will be no loss of energy in the transmission of electricity since superconducting materials do not offer any resistance. By doing so a lot of amount of electrical energy can be saved.

Compare to thick wires made of conductors like copper and aluminium, very thin cable of about a few millimetre diameter made of superconducting material will be sufficient for very long distance transmission, and thus, the government's expenditure on electricity transmission can be reduced very much.

For Storing Electrical Energy

Using superconductors, electricity energy can be stored for a longer duration without any loss of power. If electricity is passed through a circuit made of superconducting material, the current will keep on flowing for infinite time.

For Power Control

Using superconductors, such power generators can be designed which could supply a fixed amount of power and prevents the current from going beyond a certain value. There are no controllers which limit current due to the voltages exceeding 36 KV. Superconductors could be the answers as they lose their properties when current exceeding a certain level passes through them. The power in superconducting machines is thus automatically controlled which is a blessing when there is a short circuit.

For Magnetic Shielding

Firstly, there is no loss of energy during the flow of current through superconductors, i.e. they are not heated up, and secondly, they are diamagnetic in nature, i.e. they have a tendency to run away from the magnetic field and the external magnetic field lines cannot pass through them. Thus superconductors can be used as a magnetic shield too.

For Power Generators

Superconductors can be used to design alternating current generators. Existing AC generators use very high level of power releasing tremendous amount of heat in the copper conductors, during the transformation of mechanical energy into electric. Very recently in 1994, BHEL, Hyderabad had developed an electric power generator using superconducting wires. It is a compact

200 KVA generator using niobium-titanium (Nb-Ti) alloy wires and tested by connecting it to the mains supply for 30 hours. It is more compact, much lighter and can generate more power without any loss.

As SQUID

SQUID means Superconducting Quantum Interference Device. SQUID is a newly invented device used for detecting very minute changes taking place in the human brain or body to diagnose the disease afflicting it. It is a system which is made by combining two or more substances in the form of a ring. As a result of which a weak coupled joint is formed on the inner surface of the substances, which is called Josephson Joint. The Josephson Joint (JJ) made of superconductors are 100 times more efficient than the JJ made of traditional conducting substances. When this ring is placed in a magnetic field, a very large amount of electric current starts flowing. The intensity of this current is directly proportional to the intensity of magnetic field. SQUID can be very useful for the treatment of heart diseases. They can also be used to study accurately the past and present magnetic field of earth and detecting geological faults and oil well under the ground.

In Medical Science

Due to superconductors and supermagnets, there is progress in medical science too. Several medical diagnostic equipment also employ supermagnets. Based on these, the device SQUID can be used to detect a very minute magnetic change in the brain, to ascertain the diseases afflicting it. Furthermore, with the discovery of supermagnets, the cost of instruments used for cat scanning, and nuclear magnetic resonance (NMR) will also be reduced. In addition to this, with the help of magneto cardiogram, the electric current generated in human heart can also be studied.

As Mass Drivers

Mass drivers increase the velocity of substances by accelerating them and then the bodies are projected to a very long distance by using mass drivers. Superconducting electromagnetic rings can also be used as mass drivers as they can easily send any heavy luggage/body from earth surface into the space or can bring back from space to earth surface. There are lot of possibilities for the use of SQUID for surveying minerals and petroleums.

Maglev Trains (Trains in Air)

Superconductors have the property of supermagnets. Hence, using high power of supermagnets on the basis of principle of magnetic levitation special type of trains called maglev trains can be made. The maglev trains can run in air above the earth surface or in the underground tunnels at the speed of 400 km/h just like the hovercrafts run in air above the water surface in the river or sea. Such type of maglev trains have been experimentally tested in Japan. Thus, by the use of superconductors, the efficiency of submarines, ships and aeroplanes can be increased very much. The principle of maglev trains can be understood as follows:.

> If the railway line is magnetized and in the bottom of the rail compartment strips of superconducting material are fixed, then the compartment will be lifted slightly above the railway line. This way air will come in between the railway line and wheels, and thus, there will be no friction between them. As a result of which the speed of trains will become very high and the expenditure on trains will also be reduced. The considerable part of power of rail engine which is lost against the friction between the wheels

and railway lines, can also be saved. This, in fact, is based on *Meissner Effect*.

In simple language, it can be understood as follows: Suppose on your table, two bodies are lying one of which is a conductor piece say iron or copper, and the other is a piece of superconducting material. If you have a piece of magnet in your hand, you can easily put it over the conducting piece, but it will be quite difficult to put the magnet over the superconducting piece. The reason is simple, the magnetic flux lines of magnet cannot enter into the superconducting material and thus, the magnet appears to be floating above the superconductor.

In Electronics and Computers

Due to the discovery of superconductors, the electronics will see a drastic change. Presently, all the activities in electronics are based on semiconductors and the rate of flow of electrons in them. The modern radio, television, computers and all the communication processes use the diodes, and transistor which are made of semiconductors. Without these tiny devices, it would not be possible to set up communication link with the space vehicles, and to send man into the space. Since, compared to semiconductors, the rate of flow of electrons in superconductors is more than hundred times, therefore, by using the superconductors the efficiency of all these devices, and that of computer will also become hundred times. Thus, due to superconductors, very cheap and efficient computers will be available and just like radio and TV each house may have a computer.

For Superconducting Magnetic Ore Separators

Magnetic separation is one of the most important industrial uses of magnets. By this method, impurities are removed from the ores. Traditionally used magnetic separators have a magnetic field of about 2 Tesla and magnetic gradient of the order of 1000 to 2000 Tesla per metre. BHEL, Hyderabad in collaboration with NPL, Delhi, National Mineral Development Corporation and BARC, Bombay, has developed a superconducting High Gradient Magnetic Separator. It can separate even micron size magnetic impurities from the basic minerals. This has given a ray of hope that the superconductors can be used in industries to a great extent.

India's Position in the Field of Superconductivity

Indian scientists are also not behind any other country in the race of discovering high quality superconductors. The scientsts of IIT, Madras have discovered superconductors at 95k by combining elements. In addition to this, in many other laboratories like Bhaba Atomic Research Centre, Bombay; TIFR, Bombay; IISC, Bangalore; CSIR, Delhi; NPL, Delhi; and NCL, Pune research is being conducted on superconductivity. The main aim of such research is to prepare such superconductors whose critical temperature is equal to the normal room temperature.

Very recently, the scientists of National Physical Laboratory, Delhi have developed a substance which partially shows characteristics of superconductivity at room temperature. This substance has many "phases". But it has not been possible to separate out the phase which has the property of superconductivity. It is hoped to do so very soon. If superconductivity is achieved at room temperature, undoubtedly, man will be the master of a limitless power and, thus, it may be possible to improve the human life.

Teaching of Electricity at Secondary Level

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TEACHING of electricity at secondary level is important part of the total science curriculum. It lays foundation of some basic concepts like charge and its properties, current, resistor and Ohm's law. These concepts if not properly understood at this stage are likely to create hinderance in understanding physics at all levels in future. Researches have shown that many alternative frameworks are found among students of physics (e.g. Johsua 1984, Driver, Osborne and Freyberg 1985, Saxena 1994, Shipstone 1988, Solomon 1985) at various levels including secondary (Saxena 1994 a) and undergraduate and to remove misconceptions concerted efforts are required (Saxena 1992).

What to Teach ?

A look at various secondary curricula (Saxena 1995) shows that many secondary level curricula in India include different concepts and approaches to deal with. This is true for physics in general and electricity in particular. The depth up to which various concepts are discussed also varies from one curriculum to another. On the basis of the opinion of a group of teachers teaching physics and some experts it has been suggested (Saxena 1995) to include the following topics related to electricity at secondary level:

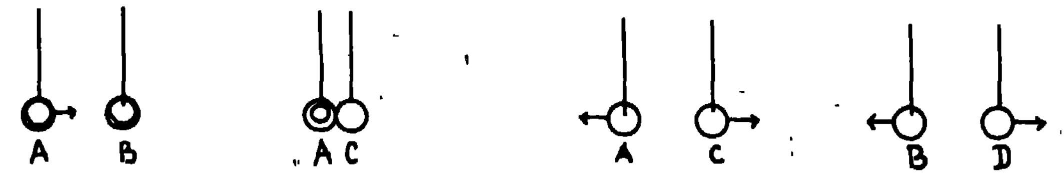
> *Coulomb's law, Potential and Potential difference, Current, Ohm's law, Resistance in parallel and series.* Primary cells, Electric motor, Electromagnetic induction, Faraday's laws of induction, Magnetic effect of current, Safety devices—fuse, earthing etc., photoelectric effect (Emphasis added).

Out of these topics, only three topics, i.e. Coulomb's law, Ohm's law and Resistance in parallel and series are suggested to be taken up both qualitatively and mathematically. Other topics are to be discussed at this level qualitatively only. Due to lack of space and some other reasons, teaching of topics/concepts included in the first paragraph shall only be discussed in this article. The teaching of remaining topics/concepts shall be discussed elsewhere.

The Approach

It has been pointed out (Arons 1990) that two approaches could be adopted. One approach introduces the concept of charge first and arrives at current at the later stage. The other approach introduces the concept of current first and concept of charge afterwards. Either of the two approaches could be adopted without encountering any difficulty. However most of the courses/books follow the first approach.

The children's first encounter with the attraction of small pieces of paper by a rubbed glass rod really fascinates them. They



Pithballs A and B are oppositely charged. They show attraction

Pithball C is touched with A, so that they acquire similar charge

Pithballs A and C show repulsion

Similarly pithballs B and D having similar charge repel.

Fig. 1

are motivated to know its cause and like to perform the activity. In place of glass rod many other materials such as a comb, a plastic rod, a plastic scale could be used. Students could be asked to find out what materials could be used for this purpose. They may also interpret it as force of attraction. This activity is easy to perform, the only precaution to be taken is that it should not be a wet day. Another similar activity is to rub an air-filled balloon with terrycot or nylon cloth and bring it close to the wall. It sticks to the wall and remains as such till it looses charge through air.

The presence of two kinds of charge is difficult to show but it is necessary. Otherwise some students draw the conclusion that there is only one kind of charge and when a body is charged it attracts an uncharged body. This is so because its later part is true and they observe it in practice. To show two types of charges, one has to demonstrate a series of experiments, which the students can also repeat and draw logical conclusion.

To show two types of charges, it is necessary that repulsive force is also demonstrated along with force of attraction between dissimilar charges. This is so because an electrically neutral piece of paper or a pithball is also attracted by induction. (Pithbal could be replaced by a small piece of thermocol in the following activity):

To establish two types of charges

(i) Two pithballs A and B are charged with opposite charges, say by sealing wax/glass rod rubbed by silk cloth and ebonite/amber rod rubbed by paper/fur; and force of attraction between them is demonstrated (Fig.1).

(ii) The pithball A is touched with another neutral pith ball C so that they acquire similar charge. When brought close, pithballs A and C show repulsion. Similar result could be demonstrated with pithball B.

Thus the children can be led to think that there are two types of charges. One has been arbitrarily named positive and the other is named negative. Moreover they cancel each other's effect, otherwise there is nothing positive (negative) in the positive (negative) charge. In no instance one finds third type of charge. A charged body attracts all bodies having one type of charge and repels bodies having another type of charge, establishing the existence of two types of charges.

The potential difference could be introduced as the condition that makes charge to flow. It could be compared with liquid level difference responsible for flow of liquid and temperature difference that is responsible for flow of heat. For convenience the electric potential of the earth is chosen to be zero. Here one could introduce the concept of conductor (insulator) as the material that allows (does not allow) flow of charge.

To show that flow of charge is current is relatively difficult task. One method could be to connect the two terminals of a 90-V

battery to the two plates of a condenser (Fig. 2) and these are shown to be charged with the helf of electroscope.

Battery and small torch bulbs could be used to study many properties of current. A simple electric board with provision of fixing many bulbs and batteries could be easily fabricated. The main advantage of such

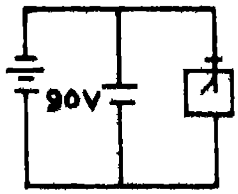


FIG. 2

electric board is in its flexibility (Fig.3). It consists of few torch bulbs fitted in bulb-holders connected to connecting terminals. Four dry cells are provided on the board and the number of cells to be used can be chosen by making appropriate connections. There are some extra terminals connected to removable copper strips. Such an electric board could be used to study various characteristics of current and the materials. Students could test which substances allow flow of current (conductor) and which do not (insulator). The intensity of glowing bulb could be taken as the indicator of magnitude of current. However a galvanometer or an ammeter could be connected for more refined experiment. Students could also make predictions and test these for themselves.

It has been found (e.g. Saxena 1994, 1994 a, Shipstone 1988) that many students carry many misconceptions about current. Most common among them is that 'current gets consumed or diminishes' as it passes from point A to B through a resistor (Fig.4). Perhaps its origin is in the usage 'consumption of electricity', 'running down the battery' and the alike. The other common related misconception is that varying the resistor effects the current down the stream only. Therefore varying the resistor r (Fig.4) would vary the current passing through point B only and not through A. The electric board with its flexibility, could be used to conduct such activities that help to remove these misconceptions.

Connecting a resistor of a fixed value, the electric board can also be used to 'discover' Ohm's law by the students. However for doing so, ammeter and voltmeter are essential to be introduced as instruments that measure current and potential difference. Moreover how are they to be connected in a

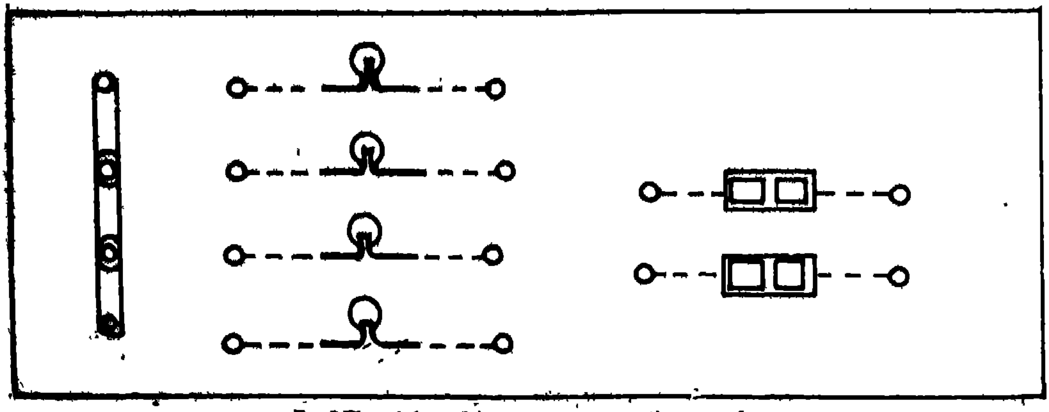


FIG. 3 Electric board (permanent connections are shown by dotted lines)

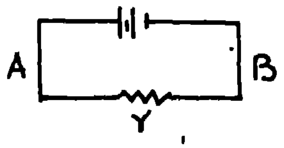


FIG. 4

circuit is also to be explained. At this stage students are not familiar with these things. Using the voltmeter and ammeter readings they plot V-I graph and arrive at Ohm's law. One could also use various kinds of conductors to see which of them follow Ohm's law.

Thus Ohm's law could be used to introduce numerical value of a resistor as proportionality constant between V and I and the unit of resistance as Ohm. No amount of description of the experiment could take place of the excitement and enjoyment students have when they conduct such an activity. Sometimes guided activity using a self-learning module (Saxena 1993) is also used for this purpose.

The concept of resistances in series and parallel is difficult for some students. They find it difficult to identify the type of connection in a given situation. It is therefore necessary to give practice by asking them to join the actual resistors and represent it diagrammatically. Particularly those students who are at concrete operational stage are helped by this practice. It is necessary to explain that two resistors are in parallel if one terminal of the first resistor is directly connected to one terminal of the second resistor and of the other terminal of the second resistor. For this reason, R_1 and R_2 are connected in parallel in Fig. 5 (a) and 5 (b), but not in Fig. 5 (c)

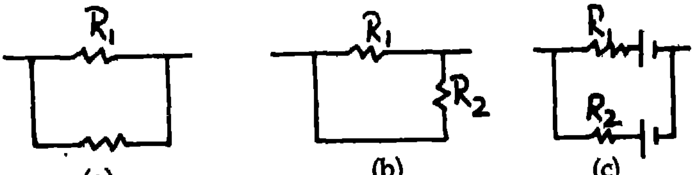
The total effective resistance ot two resistors connected in series or parallel could also be introduced using electric board. Apart from deriving the theoretical formula, these could be verified experimentally. It is also useful to give physical explantation of the total effective resistance, particularly in case of parallel.

In case of two resistors R_1 and R_2 connected in parallel, the total resistance $R < R_1$ or R_2. Students find it difficult to appreciate though it can be shown mathematically that,

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{R_1}{R_1/R_2 + 1} < R_1$$

When the resistor R_2 is connected in parallel, it provides an 'extra' path for current to flow. Therefore current is more than the case when R_1 is connected alone. Thus it lowers the total resistance when another resistor is connected in parallel.

Application of Ohm's law to calculate current in a branch is not always an easy task for the students. In a circuit such as shown in Fig. 6 many students opine (Johsua 1994, Saxena 1990) that current passing through two resistros R_1 and R_2 is not equal, but unequal. Their argument is thay by Ohm's law current through resistor R_1 is E/R whereas current through resistor R_2 is E/R_2.



(a) (b) (c)

FIG. 5

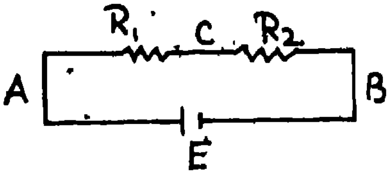


FIG. 6

This misconception is sometimes very strong and needs special attention by the teacher. The following arguments could help to clarify: Potential difference E is applied across points AB and not across AC or CB. Hence, Ohm's law can be applied for the total resistance between AB and not on parts. Secondly, we also need to think consequences if different current is passing through points A and C. Is it possible, while charge is conserved? In one case the charge is being created and in the other cases, charge is destroyed between the two points A and C. Finally, students could also experimentally measure current at different points of the circuit and verify that the current is equal.

Finally, in the Appendix, sample evaluation questions are also given that could be used to test students' conception at various stages of teaching. It is necessary that apart from marking the choice among the possible responses, the teacher asks the students to explain his reasoning. This would further give hint to the students' line of thought. Remedial steps could be taken to remove misconceptions if any. For this purpose, some remedial activities are already discussed in the text.

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APPENDIX

Sample Evaluative Questions

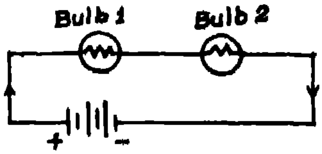
1. When a glass rod is rubbed with silk cloth, it gets charged: (i) How does it happen? (ii) Why is it that nature of charge on the rod is opposite to that of charge on silk cloth?

While rubbing a body A with body B, is it possible that only one body is charged? How? If not, why?

Why is it that an ordinary glass rod does not attract/repel an ordinary pith ball, when both of these have charges present on them?

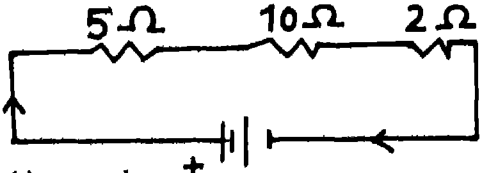
When a comb is rubbed and charged, is the charge produced instantaneously?

A circuit consists of two identical bulbs connected as shown. When current is passed, what is true about brightness of the two bulbs?



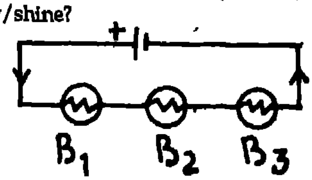
(a) Bulb 1 will be brighter
(b) Bulb 2 will be brighter
(c) Bulbs 1and 2 will be equally bright
(d) Only one bulb will glow at a time.

In a circuit, three resistors of 5 ohm, 10 ohm and 2 ohm are connected as shown. The current passing through the three resistors would be



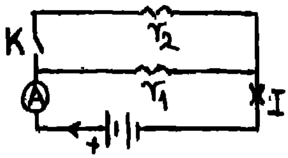
(a) equal
(b) unequal, highest through the resistor of 2 ohm
(c) unequal, highest through the resistor of 5 ohm
(d) unequal, lowest through the resistor of 10 ohm.

7. Figure shows three bulbs connected to a battery. Bulb 2 gets fused. In such a case, which bulb(s) will glow/shine?



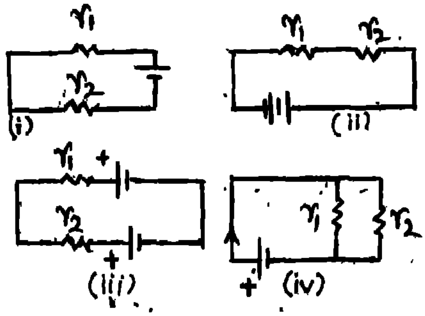
(a) Bulb B_1 only
(b) Bulb B_3 only
(c) Bulb B_1 and B_3
(d) None

8. When key K is open, current I passes through the ammeter A. When key K is closed, the current I would



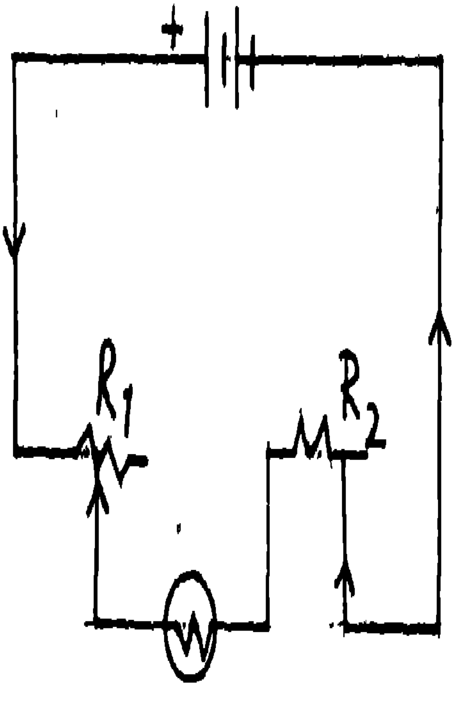
(a) increase
(b) decrease
(c) remain same
(d) increase or decrease, depending upon values of r_1 and r_2.

9. Fig shows four circuit diagrams with resistors r_1 and r_2. Which circuit(s) show(s) resistors connected in parallel?



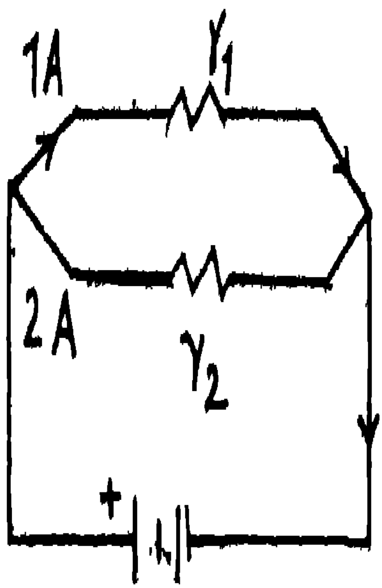
(a) (i) and (iv)
(b) (iii) and (iv)
(c) All four
(d) (iv) only

10. R_1 and R_2 are two variable resistances connected to a battery and a bulb as shown. If R_2 is decreased, the current passing through the bulb would



(a) decrease
(b) remain same
(c) decrease

11. In the figure, the current passing through the resistors r_1 and r_2 is 1A and 2A respectively. The potential differences across r_1 and r_2 would be



(a) unequal, more across r_1
(b) unequal, more across r_2
(c) equal across r_1 and r_2
(d) equal/unequal depending upon values of r_1 and r_2.

Brain-storming Problems in Mathematics for School Teachers

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THE ROLE of a teacher in the education system is pivotal and therefore the role of any educational system rests with the teacher. There are two types of teachers to whom we have every reason to be grateful. There are teachers who teach us facts, who introduce us in a meaningful way to a subject, lay solid foundations and on these foundations rise the tower of knowledge properly and firmly. But there is another rare type to have an attitude to life, an outlook on the world for which we are ignorant. They open our eyes to a new dimension and teach us to see life in a new way. Thus from such teachers one can get two things, which good education must provide, firstly a certain intellectual habit and attitude of mind, secondly a view of life.

A teacher in the classroom has to play a critical and catalytical role not only in recognising the creative potentiality but also in providing adequate facilities for developing the same to the maximum. He/she has to organize various activities, to motivate his/her students and promote his/her interest and aspiration. He/she can inculcate the habits of reading among the students and create interest in the subject.

Learning of mathematics can hardly be limited only to the classroom and what is contained in the textbooks. A good teacher has a responsibility to tap numerous resources before handling a classroom lesson. He/she has to explore and indicate further materials and resources which students may later use for deepening their understanding of new concepts of mathematics. Creation of interest in mathematics should be one of the objectives of a teacher. All care must be taken that there is no element of boredom in learning mathematical concepts. An excellent/effective teacher can successfully achieve the goals of the society and the nation. Some of the factors which influence teacher effectiveness are: (a) intelligence, (b) academic qualification, (c) general, cultural and special subject-matter knowledge, (d) professional information, (e) emotional adjustment, (f) attitude favourable to students, (g) strong interest in reading literary matters etc.

The high school/secondary school teachers live in their own world. This is not conducive for advancement of knowledge either among students or teachers. A teacher of today has to devote more time and energy to productive and creative activities, interactions, discussions and to update knowledge. In addition to curricular coverage, he/she has to see the interest of high achievers. The teacher should motivate these

children to tackle and solve some of the challenging subject-problems and direct them to take various olympiads examinations, in mathematics, which are regularly held in our country by various educational agencies.

Following are the few problems with their solutions which may be useful for teachers as well as for students'' awareness.

Problem 1: Every letter in the division OHHOOH ÷ Game = HO, uniquely represents a digit in the decimal scale of notations. Find the digit which each of the symbols represents.

Solution: This shows that HO>OH, H ≠ O (given) and O is not equal to zero.

HO lies between 10 and 100 but it cannot be numbers like 11, 22, 33 etc.

Also we find that digit O when multiplied by the digit E will give a number which has digit H in the unit place. The numbers satisfying this condition are 21, 31, 41, 42, 43, 51, 53, 61, 62, 63, 64, 71, 73, 81, 82, 83, 84, 86, 87, 91, 93 and 97. Of these, only 73 fits the case, as it divides 377337 exactly 5169 times.

Hence solution is H = 7, 0 = 3, G = 5, A = 1, M = 6, E = 9.

Problem 2: Show that all positive values of a, b, c, d .

$$\frac{(a^2+3a+1)(b^2+3b+1)(c^2+3c+1)(d^2+3d+1)}{abcd}$$

cannot be less than 625

Solution : Since a>0, b>0, c>0, d>0

let $k = a + (\frac{1}{a})$

For minimum value of k

$$\frac{dk}{da} = 1 - \frac{1}{a^2}$$

$= 0 \rightarrow a = 1 \rightarrow k = 2$

Hence $a + \frac{1}{a} \geq 2$ similarly $b + \frac{1}{b} \geq 2$; $c + \frac{1}{c} \geq 2$, $d + \frac{1}{d} \geq 2$

Therefore $\frac{a^2+3a+1}{a} = a + \frac{1}{a} + 3 \geq 5$

Similarly it holds for other.

Hence the expression cannot be less than 625.

Problem 3 : Show that if a, b, c are the lengths of the sides of a triangle, then $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$ are also the lengths of the sides of a triangle.

Solution : Given a, b, c, are the lengths of the sides of a triangle, therefore, a+b > c.

Since a > 0, b > 0, therefore, $\sqrt{ab} > 0$

Thus $a + b + 2\sqrt{ab} > c \Rightarrow (\sqrt{a} + \sqrt{b})^2 > (\sqrt{c})^2 \Rightarrow \sqrt{a} + \sqrt{b} > \sqrt{c}$

Similarly, we can test the other two inequalities.

Hence, $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$, are the sides of the triangle.

Problem 4 : Prove that if number p is of the form 999....., where there are at least 1000 9s at the beginning, then $\sqrt{p}$ also has at least 1000 9s at the beginning.

Solution : If $0 < a < 1$ then $a^2 < a$. Here we can assume that $\sqrt{p} < 1$ (for if $\sqrt{p} > 1$ then p>1).

But p has 1000 nines at the beginning

Since $\sqrt{p} > p < 1$, it should have at least 1000 nines at the beginning.

The 1001st place of $\sqrt{p}$ being ≥ the 1001st

place of p.

Hence the proof.

Problem 5 : Let $X \neq 0$, b an (n+1) digit integer in base 5, as

$x = a_n5^n + a_{ny}5^{ny} + ... + a_05^0$ with $0 \geq$

ai (i = 0 to n) $\geq$ 4

Find $y_1 = (\frac{x}{a_n+1})_{max}$ and $y_2 = (\frac{x}{a_n-1})_{min}$

Solution : For any value of a_n, the greatest value of x is obtained when

$a_{n-1} = a_{n-2} = ... = a_0 = 4$

$x = a_n5^n + a_{n-1}5^{n-1} + ... + 4.5^0 =$

$a_n5^n + 5^n - 1 = (a^n + 1)5^n - 1$

or $\frac{x}{a_{n+1}} = 5n - \frac{1}{a_n+1}$

Thus $\frac{x}{a_n+1}$ will be maximum if $5^n - \frac{1}{a_n+1}$ is maximum $\Rightarrow \frac{x}{a_n+1}$ is minimum

$\Rightarrow a_n+1$ be maximum . Hence $a_n = 4$

So $y_1 = (\frac{1}{a_n+1})$ max $= (5^n - \frac{1}{5})$

For any value of a_n, the least value of x is obtained when $a_{n-1} = a_{n-2} = ... = a_0 = 0$

Thus $x = a_n5^n = (a_n^{-1})\ 5^n + 5^n$

$y_2 = \frac{x}{a_n-1} = 5^n + \frac{5^n}{a_n-1}$

For y_2 to be minimum a_n-1 has to be maximum. But 5^n is fixed.

Thus $a_n = 4$

Hence $y_2 = (\frac{x}{a_n-1})$ min $= 5^n + \frac{5^n}{3} = \frac{4}{3} \cdot 5^n$

Problem 6 : We are given eighty coins, all of the same size and shape. One of the coin is counterfeit and is lighter than the others. Locate the counterfeit coin by using four weighings on a pan balance. Generalise your result to any number N of the coins.

Solution: First weigh with [83/3] +1 = 27 coins in each pan where [x] denotes greatest integer function. If the weights are equal, the coins are genuine and the counterfeit is among the rest 26. If the weights are not equal the pan with lesser weight contains the counterfeit coin. So, now we have to find the counterfeit coin from among 27 or 26 coins with three weighings left.

Next weigh with 9 coins in each pan. If the weights are equal, the counterfeit coin is among the remaining 9 or 8 coins. If not, the pan with lesser weight contains the counterfeit coin. Now we have to find the counterfeit coin from among the 9 or 8 coins with two weighings left.

Next weigh with three coins in each pan.

Next weigh with one coin in each pan.

The counterfeit coin is traced.

Generalisation: If we have *n* weighings, then we can spot the counterfeit coin from among at most 3^n coins (i.e. $n = \log_3^N$). If $\log_3^N$ is not an integer (when N is not a power of 3) the next higher integer is taken.

Developing Take-off Norms for Interactive Book on Environmental Studies

At Grade Level Three

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Environmental education being a recent concept has a scope of combining the process of learning and content areas encompassing natural, social and cultural environments. Further it can also combine the learning and life skills, if presented properly to children. For this purpose, a three-day workshop resulted in the development of certain norms for environmental studies textbook for grade level three. These norms can work as starting point for the textbook writers and can be further improved through subsequent experiences.

ENVIRONMENTAL education is a recent concept that started in early seventies and it has been introduced as a subject in primary classes in India since eighties. The concept of environmental education though multi-dimensional in nature, it dwells basically on three broad areas, namely: natural, social and cultural environments (Patel & Patel, 1994).

The US Environmental Education Act (1970) envisages environmental studies as the educational process dealing with man's relationship with his natural and man-made surroundings. According to Patel & Patel (1994), environmental studies are meant to create an awareness and uderstanding of the evolving total environment; it's natural, man-made, cultural and spiritual resources, together with rational use of conservation of these resources of development.

The above-mentioned definitions of environmental education indicate the plausible content areas only.

The recent international conference on quality of education organised by the Council of Boards of Secondary Education (COBSE) in Delhi on 4 November 1993, highlighted the concern for coping with the knowledge explosion. During the conference it was emphasised by Dave (1993) that education is going to be the main process of empowering people in 21st century. In order to meet such a contingency, the curriculum would have to emphasise 'learning how to learn' and it won't be information-based, rather it will be process-based. Therefore, the content requires to be linked with the process of learning and skills of generating new information.

Keeping in view the emerging fresh demands on curricula geared to the proceses of generating knowledge, it was thought to attempt on producing an EVS textbook emphasising interactive learning and learning processes. For this a workshop was organised in September 1994 to produce such textbook on environmental studies under the auspices of Lok Jumbish Parishad.

Methodology

A group of 18 participants deliberated during the workshop organized in September 1994. The profile of the group is shown in Table 1.

On the first day, a group discussion was done to prepare a consensus and clarity about the EVS instructional material to be produced.

TABLE 1

Category	*No. of participants*	*Experience in*	
		Writing for childern	*Participation in workshops and in in-service training*
Teacher educators	5	3	5
Subject experts	3	3	3
Teachers	10	1	10

On the first half of the second day, norms for the proposed EVS book were worked out on the basis of earlier experiences of the participants and discussion with the teacher participants for the practicality of those norms. In the second half of the day, reference materials were collected and photo-copied for producing sample material. The workshop participants went through the material to pick up the best style of writing in which more learning material is envisaged.

On the third day, participants in the group of three or more produced some lessons on EVS topics for discussion. Then written lessons were critically discussed so that writing style becomes clear further.

Results and Discussions

The result of the workshop are summarised in Table 2.

TABLE 2

Summary of the book requirement of interactive EVS textbook (Class III)

1. Average learning time for each lesson	:	4 Hours
2. Total number of days available to teachers	:	140 days
3. Days for evaluation, corrective feedback	:	30 days
4. Extent of each written lesson	:	5-6 pages
5. Number of lessons	:	30
6. Size of each para	:	30 words
7. Size of each sentence	:	10-15 words (Maximum)

Drawing upon the experiences of the participants of the workshop on text-reading ability, text-understanding ability and picture-reading ability of children of age group 8+years, the following consensus was reached for providing proportionate space in the book.

Space for.......	*Percentage*	*Remarks*
1. Pictures and illustrations	30%	Two colours
2. Writing space for children (as book has interactive mode)	20%	Triple space
3. Written information	35%	16-point
4. Formatting space (space between lines, paras, around illustrations)	15%	standard

After discussion, the following methods for starting the lesson emerged.

The starting of lesson may be done by

— an activity
— a picture
— a short song or poem
— a riddle
— a conversation

Further discussion resulted in the advocacy of use of the certain techniques of writing lessons for EVS as the children are beginning to study EVS for the first time at the grade level three. This fact requires linking EVS presentation with the techniques of langauge so as to have a linkage with the subject that children have already studied at grade levels one and two.

The techniques to be followed for EVS at grade level could be as follows:

— Story narration method
— Poetry method
— Illustrative strip method
— Open-ended questions method.
— Providing interesting information and linking it to extension activity by children.
— Activity and demonstration methods.
— Educational games
— Field trip and excursion narrative
— Presentation and project work method.

It was emphasised that in stories and poems the ratio of flight of imagination or fantasy to facts should be 1:4. Where it is possible linking EVS with mathematics may also be incorporated, at least 5% linkage may be established.

After the main norms of the textbook writing are worked out, it is desirable to taper off the group to a smaller cohesive group to start the writing work. The number of people in the smaller group can be on the basis of one member for each four lessons to be written.

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Increasing the Reliability of an Examination

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AN EXAMINATION is a device to assess the quality and quantity of physics learning. The device gives an assurance of a certain level of competence reached by the candidates. The assurance need be understood by others for millions of students take Senior Secondary School Leaving Examination conducted by different Boards in India. The observation is therefore expressed in terms of scores or grades. The assurance is thus a certificate to the effect that the student if selected, say, for an engineering course, has an adequate capacity for coping with the requirements of the advanced course. There are several Boards giving score sheets to their candidates. If the examinations were reliable the certificates would be acceptably equivalent. But, in general, for reasons that different Boards have different structures of examinations, the score sheets are not comparable. One option in vogue is the Competitive Examination. But that is not the answer for determining the equivalence and rank order for admission due to many reasons. For example, avoidable wastage of time, energy and efforts of the college where the students seek entry.

A recent news item is disturbing. A student getting one mark in physics in a competitive examination was admitted to an engineering college in Madhya Pradesh. Also the research findings on the performance of the students who appeared in a competitive examination reveal that students obtaining less than ten marks were selected for admission in the engineering colleges of Punjab. It is a clear evidence that the selected students have not attained the minimum standard of physics during a course of two years' study at the senior secondary level. Hence reliability and comparability becomes doubtful. The issue, therefore, is the reliability (as also the comparability) of an examination and the possible ways of increasing it.

Reliability

A reliable examination is one which gives a consistent score at two different occasions. If scores of a student at two different occasions are irregular, the test is not reliable. If the scores for some candidates are higher and for others lower, it could mean the questions are poor or the marking is not consistent. Assuming that the teaching, learning, evaluating methods are appropriate and adequate courses are covered, there could be three cogent reasons for the irregularity in the scores.

1. The different examiners have different interpretation and expectation of candidates' answers.

2. The examination system tends to overemphasise the theory. The ability to communicate physics ideas

through practicals is not considered important. This leads to the neglect of the necessary component of physics learning and its testing via practicals examination.

3. External influence. When external paper and examiner is employed, the teachers and the students begin to cooperate in a way which disorients physics learning. Both make conscious omissions in their work due to scramble for high marks. The physics teaching is then unwittingly designed to provide for routine questions of problem-solving without arousing any exploratory interest in physics learning. In fact, question/content spotting i.e. guessing the content of the examination in advance by consulting a few past papers becomes a common practice. That makes the syllabus a nonsense document. The intention of giving a comprehensive grounding in physics is obviously not fulfilled. The influence is all the more deeply painful in case of competitive examinations which indeed dictate the contents and the methods of learning/teaching distortionately.

The Possible Ways

To overcome these difficulties and make the examination really more reliable and consequently score sheet truely comparable, a few possible ways are described below; however, I will discuss somewhat in detail the multiple choice type objective examination as also the item analysis which is an essential requirement for setting a good question paper.

1. *The detailed marking scheme.* It reduces differential interpretation and expectation of the evaluators.
2. *Multiple Marking.* By increasing the number of examiners, the personal biases are reduced to a minimum. Two examiners and a coordinator would be enough. Multiple marking is important for questions of the exploratory nature.
3. *Long Examination Paper.* It ensures adequate coverage of the syllabus. It reduces the element of spotting the content.
4. *Physics Practical Examination.* It reduces the over-emphasis of the written word. It gives additional information about the experimental skills. For instance, those of observation, measurement and interpretation developed during the course of two years' study.
5. *Multiple Choice Type Objective Examination.* This type is considered most suitable and reliable for testing quality and quantity of physics learning. The questions and answers are carefully framed beforehand so that there is no chance of personal opinion of an examiner involved while marking the scripts. Naturally, the designing of an item is a highly skilled job demanding item analysis. We shall return to it later. First we shall look at the different aspects of this type of the examination.

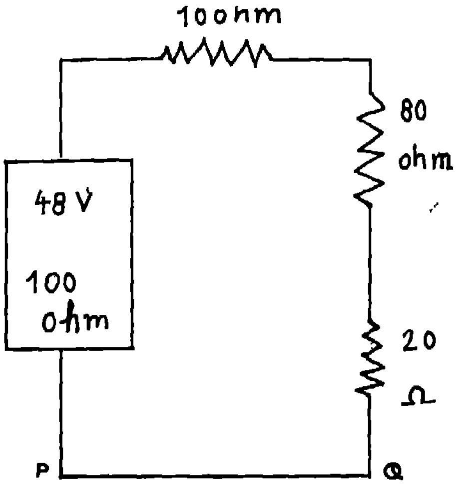
Multiple Choice Test can have one or several answers correct. Two model examples are taken from the National Standard Examination in Physics (NSEP) conducted by the Indian Association of Physics Teachers (IAPT) in 1995. This examination which aims at testing the analytical and experimental skills has three parts; Part A and B concerns theory and Part C deals with practicals. Part A contains 40 multiple choice questions with one answer correct and 10 questions with

several answers correct.

Q. 29. In the circuit diagram shown, the potential difference across P Q will be nearest to

(a) 9.6 V (b) 6.6 V

(c) 4.8 V (d) 3.2 V



This question tests the candidate's ability to apply Ohm's Law. It has one answer correct.

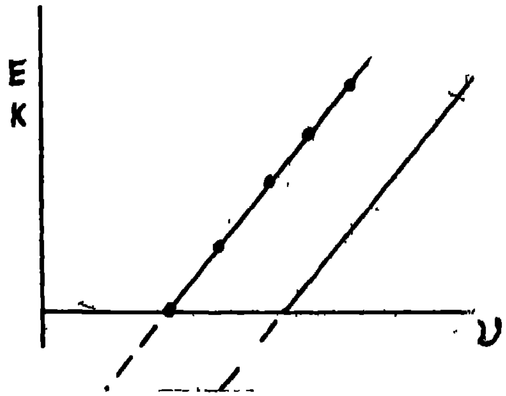
Q.43. In a Millikan's experimental graph regarding photo-electric effect, which of the following statements hold true?

(a) x-axis shows wave length of light used,

(b) y-axis shows the kinetic energy of the slowest among the electron ejected,

(c) The intercept on the x-axis is proportional to the work function of the cathode.

(d) The two graph lines for different cathodes are always parallel.



This question has two answers correct. Here the ability to interpret the graph provides a glimpse of the level of the comprehension of photo-electric effect.

Comments on Multiple Choice Testing

This kind of test has two merits:

1. The marking is invariably impartial.
2. This type of test enables a careful control of the difficulty level of an item. This control makes it possible to decide in advance the spread and frequency of each level of the difficulty. This requires the libraries of the examination which unfortunately is not available in India.

The multiple choice test has two defects.

1. *Guessing*. When only one answer is correct, guessing does occur. But when several answers are correct, guessing is not possible.
2. *Creative work cannot be assessed accurately*. For example, skills in organising and presenting knowledge in a lucid, concise, precise and fluent manner. However, these defects can be corrected. We shall illustrate by examples from NSEP, Part A & B, 1995.

Guessing

It is natural to guess when there is a chance of finding a correct answer from several alternatives. In Part A-1, each question has four options. The probability of correct answer is clearly one in four. The performance of one candidate is given for completely eliminating guessing factor as below:

Number of questions attempted	=	34	(40)
Number of correct answers	=	29	(14)
Number of wrong responses	=	5	(26)

Now there is every chance, the candidate has guessed = 29 x 1/4 = 7.25 answers correct. His credit should therefore be = 29-7.25 = 21.75 answers. Over all Score = 21.75 x 4 = 87. If one mark is the penality for one wrong answer, his correct marks would be = 87 - 5 = 82. A simple formula is given as follows:

$$\text{Marks, } M = \left(R - \frac{W}{C-1}\right) \times 3$$

$$= \left(29 - \frac{5}{4-1}\right) \times 3 = 82$$

That is what the student deserves and obtains.

The performance of another candidate is given in the brackets. Here the probability of guessing is very high and the formula helps eliminate guessing.

Testing of Creative Work

The divergent thinking can be tested by a few methods listed below:

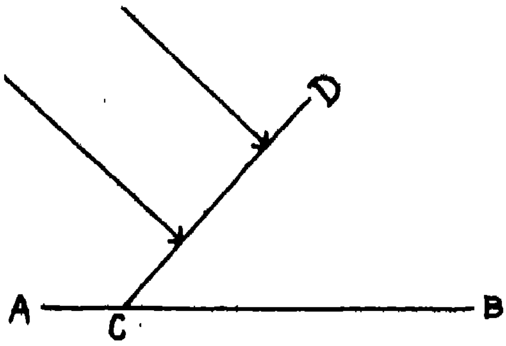
1. Short essay type questions.
2. Short derivations.
3. Sketching diagrams with correct labelling and positioning of the components of an instrument of experimental setup.
4. Short explanations of a situation.

Part C of the NSEP has 10 Socratic Questions for which the study of responses of the students gives an excellent insight into the creative thinking of students.

However, the author gives an illustration from Part B of the NSEP, 95.

> Q.53. Figure shows that AB is a cross-section of the surface separating two media and CD is the section of a plane wavefront incident from medium-1. The speed of the waves in the medium- 2 is 1.5 times that in medium -1. Using the Huyghen's Construction, obtain the refracted wavefront.

This activity of locating the refracted wavefront provides a method of determining the level of comprehension of the Huyghen's principle.



Item Analysis

The discussion of the nature of the multiple choice type objective examination leads me to a very important point of control of the examination. That is the need of an item analysis. The blue-print of a paper has three dimensions.

1. The educational objectives of physics learning. This dimension requires the specification of the intent of the question in terms of
   (a) Knowledge,

(b) Comprehension and application and
(c) Analytical and evaluatory skills.

2. The adequate coverage of the prescribed syllabus. The topics are classified with relative importance decided for their evaluation.

3. The mode of testing. For example, activities or questions or experiments.

Having created the ground plan of skills, topics and activities, we devise appropriate items. Two important indexes for forecasting the suitability and effectiveness of the test items are:

1. Facility index, f and
2. Discriminative Index, D.I.

Two illustrations, one from the NSEP Part A & B, 95 and the other from NSEP Part C, 94 are given as reference for physics teachers. The number of candidates who appeared at the national level are top 1% i.e. 292 which includes 24 gold medalists also. It may be noted that for any sample analysis not less than 30 students are required.

TABLE 1

Analysis of Responses of Candidates NSEP Part A & B, 95

Questions	*Correct Responses* Top (40%)	Bottom (40%)	*Total*	*D. I.*	*f-value*
Type A-1					
Q - 11	69	35	155	0.38	0.58
Q - 29	90	78	244	0.15	0.91
Type A-2					
Q - 43	73	19	125	0.49	0.47
Q - 50	100	78	247	0.09	0.92
Type B					
Q - 53	27	11	47	0.14	0.16
Q - 54	101	28	155	0.60	0.53

We find from Table 1 that Q: 29 and 50 (too easy) and Q-53 (too difficult) are not reliable for assessing the quality of physics learning. So, these questions are not suitable for any good examination paper. Q-29 and 50 show that a good number of weak students are bright. Q-53 does not reveal any degree of competence even of bright students. A good spread of difficulty level for items of the paper lies within the range varying from 0.3 to 0.7. Ideally F-value is 0.5. There is no hard and fast rule for the range. Experience is the only guide for the acceptable range of the f-values.

Again the discriminative quality of the items Q-29, 50 and 53 is not good at all. For Q-29 and 50 even the weak students appear to rise up the rank order whereas Q-53 it is hardly discriminatory for being equally difficult for weak as well as bright students. The ideal value of D.I. is 0.5. A similar argument, as for f-values, holds true for D.I. of the items of the Question Paper.

The item analysis, thus, helps us to decide in advance

1. The spread and frequency of the difficulty level of the items required for examining a given ability group.

2. The discriminative quality of an item for determining the relative rank order of the students correctly.

Laboratory Components

The practical examination in physics considerably enhances the reliability of the theory examination. The analysis of the responses of the candidates who appeared in the NSEP Part C, 94 shows that the practical examination is very reliable for assessing the level of abilities attained by the senior

secondary students via experimental skills.

TABLE 2

Analysis of Responses, NSEP Part C, 94
Number of candidates : 168

Indexes	P	Q	R	S
f- values	0.31	0.41	0.31	0.35
D-values	0.57	0.51	0.38	0.44

The Part C has four sections: P section with six short experiments; Q with three medium; R with one long experiment and S with some questions about the techniques of the experiments. The physics practical examination helps to assess the abilities of observation, measurement, interpetation of data or use of techniques, say, for locating resonance position, removing parallax, or setting up an equipment/apparatus. These abilities are not duly assessed by the theory examination. Table 2 shows very clearly that practical examination is extremely reliable for assessing the students' profiency in abilities acquired by the +2 level students.

To increase the reliability of a physics examination, a component of laboratory work is absolutely essential. The experiments can be selected on the basis of the item analysis as discussed above. The NSEP Part C is a good model developed by the IAPT resource persons.

Conclusion

The reliability of an examination has an extreme importance. It makes the marks meaningful. It helps to compare easily the marks of different Boards of examination. There are several techniques of increasing the reliability of an examination. Item analysis is an essential technique because it enables the examiner in advance to take necessary educational decisions. Any teacher of physics can use it to prepare his own question bank which can be used to design a reliable test. Also, an equivalent test with computer programming. Two important tips for the physics teacher are:

1. Cultivate a professional sense of excellence.

2. Be transparent in the testing process. Secrecy is very antithesis of the reliability.

Science News

New Cholera Vaccine

A new Indian vaccine for cholera, a re-emerging infectious disease, is ready for human volunteer trials.

The vaccine has been developed from a genetically engineered non-toxic strain of the cholera bacterium, *Vibrio cholerae 01* by scientists at the Institue of Microbial Technology, Chandigarh.

This is a departure from traditional global research efforts to develop a new cholera vaccine based on live but weakened toxic strains from which all harmful components have been knocked off.

The Indian vaccine has shown good promise in animal studies, reported the IMTECH scientist, Dr Amit Ghosh, whose team collaborated with Dr. G.B. Nair of the Natural Institute of Cholera and Enteric Diseases and Dr. R. K. Ghosh of the Indian Institute of Chemical Biology, Calcutta, to develop the new product.

The progress with the vaccine was reported at a workshop on infectious diseases held in New Delhi.

Cholera continues to claim many lives in developing countries, although it can be controlled through improved sanitation that has been the bane of the Third World.

Dr. Ghosh said the team is planning to file a patent for this breakthrough. The cholera toxin consist of two protein sub-units— an "a" sub-unit that is responsible for the harmful effects and a "b" sub-unit that confers immunity against toxicity.

New Intelligent Robot

A robot that writes letters and another that plays table tennis are being developed by defence scientists in Bangalore who have also built India's first intelligent robot with stereo vision that can navigate by itself avoiding obstacles just like a real human being.

With further refinements, the army may find this robot with 3-0 vision, useful in mine clearing and other secret commando operations while scientists claim that it also may find civilian applications on shop floors as autonomous guide vehicle.

The robot has been developed at the Centre for Artificial Intelligence and Robotics, one of the laboratories under the Defence Research Development Organization. It is currently being evaluated within the laboratory building. "Right now we are conducting trial runs on level ground and it is working remarkably well," said Mr Mathukumalli

Vidyasagar, the Director of CAIR.

Unlike the wire-guided robots that have been developed elsewhere, the CAIR robot is guided by light reflected from either side of its centre line. The robot is battery driven and two cameras, which act as 'eyes', endow the device with binocular vision.

The beauty of the system is that the cameras are not fixed in the robot itself, but on a different platform. From there the images are sent by radio to a computer. After processing the image, the computer uses a home-made software to calculate the safe path and transmits this information in real time to the robot by radio.

During actual military operations, the cameras and the image processing computer can theoretically be carried in an aircraft and the robots, dropped in the enemy territory, can be imparted vision using very high frequency radio link.

According to Mr. Vidyasagar, the pace parallel computer developed by DRDO was used to develop the 3D vision for the robot. He said that computer vision "is an important research area that involves many difficult computationally intensive problems".

The institute also developed a "gantry robot" with an ultrasonic test probe that was used to detect any flaw in the composite wing of India's Light Combat Aircraft.

Cure for Fatal Genetic Disorder

A 30-year-old discovery by an Indian-Canadian researcher and his colleague has been found to successfully treat a fatal genetic disorder that kills children below three years.

The research by Dr. Bibudhendra Sarkar of Toronto's Hospital for Sick Children to treat patients with Menkes Disease has yielded positive results, according to Ms Liz Leak of the HSC.

Back in 1966 Dr Sarkar and his colleagues in the biochemistry research laboratory discovered copper-histidine, a substance which occurs naturally in the body and enables cells to absorb copper, an essential component of many enzymes that are important for neurological functioning, Ms Leak said in a statement.

In 1976, Dr. Sarkar and Dr Andrew Sass-Kortsak decided to use copper-histidine as a treatment for Menkes Disease, a fatal genetic neurological disorder which prevents the body from absorbing copper from food.

Dr Sarkar said children with Menkes Disease die before the age of three.

We knew almost immediately after giving the treatment that it was effective. What we did't know was how desperately the patients needed it, Dr Sarkar said.

His research has now been confirmed by a report in the January issue of *Nature Genetics*. In a rare twist of events, a medical discovery at the Hospital for Sick Children, Toronto, 30 years ago resulted in the treatment of a fatal genetic disease in children, before the disease gene was discovered, said the report.

The magazine has confirmed the effectiveness of the treatment of Menkes Disease by identifying the severity of the defective gene in the treated patients.

There are clinical variations in Menkes disease, so one could not tell for sure whether these were severe cases or milder forms, the report said. It is only now, with the complete identification of gene mutation in these patients that the efficacy of this treatment is confirmed.

Dr. Sarkar said he is currently helping to set up a Menkes Disease Treatment Centre at the All India Institute of Medical Science in New Delhi. Dr. I.C. Verma, Profes-

sor of Pediatrics and a well known Clinical Geneticist at the WHO Collaborating Centre in Genetics at AIIMS, is setting up the treatment protocols.

Menkes Disease, Ms Leak said, appears in several forms and at the time of the new treatment. It was impossible to tell how severely the patient was affected. "But in 1993, Mankes Disease gene was identified, making it possible to test patients for the genetic mutation and determine if they have a mild or severe form of the disease, she said.

"What we can now say conclusively is that the treatment is effective even for patients with the most lethal variety of the disease," Dr. Sarkar said.

"Copper-histiding treatment is now used in Mankes patients throughhout the world, said Ms Leake. She referred to two Canadian patients who received copper-histiding treatment through the HSC: One at age 19 is the world's longest surviving Menkes patient. Ms Leake claimed "Both patients have the most severe form of the Menkes gene mutation and would not have surrvived without the treatment", she added

Belching of CO_2 Caused Mars Extinction

At a recent meeting of the Geological Society of America in New Orleans, Drs Andrew Knoll of Harvard, Richard Bambach of Virginia Polytechnic Insititute, and John Grotzinger of Massachusetts Institute of Technology presented evidence that it was a surge of carbon dioxide that knocked off the trilobites and the companions.

Three American Scientists have come up with a novel explanation for the most cataclysmic event that ever struck the Earth "the destruction of 95% of living species 250 million years ago". They reckon it was the global equivalent of what happens when you open a bottle of champagne.

The permian extinction is well documented in the fossil records, and the best explanation for it until now has been a massive volcanic eruption that altered the climate. But nothing lubricates the imagination like a good extinction.

The first clue came from a layer of rock from the late permian, which the scientists recognized as an inorganic carbonate. Most of the carbonate rocks are formed from the remains of animals, but this one had precipitated directly from sea water, presumbaly when dissolved carbon dioxide reached a very high level.

The cause, they believe, was a shut-down of ocean circulation towards the end of the permian. At the time, all the continents grouped together in a supercontinent called Pangaea, and the oceans were sluggish because there were no continental ice sheets to chill the surface waters and make them sink to the depths.

At the surface, living things were busily extracting carbon dioxide and adding it to the ocean's store. This thinned the atmosphere of carbon dioxide, cooling it in the obverse of global warming, and eventually leading to an ice age. That would have stirred the oceans at last, releasing the dissolved carbon dioxide with all the frenetic enthusiasm of a Grand Prix driver on the podium.

Ingenious, but where's the evidence? Apart from the rock, the three pointed to some other straws that hind they may be on to something. There is some evidence of glaciation in the late permian, and the isotopic composition of carbon in the rocks hints at rapid oceanic turnover.

The pattern of extinctions also fits. The creatures that suffered the greatest losses were those least tolerant of higher carbon

dioxide levels: those that did best were marine burrowers which spent their lives in sediments where carbon dioxide levels were already high.

The thesis had a reasonable reception in New Orleans. "It isn't as yet backedup by a tremendous amount of data," palaeontologist Dr Douglas Erwin of the US National Museum of Natural Histroy told *Science* with masterly understatement, that he thought that as an interesting, even fascinating hypothesis.

New Deadly Virus Hits Humanity

Dr. Jan Clement and colleagues at Queen Astrid Military Hospital in Brussels said they documented 16 cases of hantavirus among the U.S. soldiers on an exercise in Ulm, southwest Germany, in 1990. All 16 recovered after treatment.

"All cases except one originated from one 177—member military unit, including seven women; the attack rate was 8.5%.," they wrote. Many of the affected had reported 'using hay in sleeping areas'.

Hantavirus, a mysterious and deadly infection carried by rodents, has broken out among the U.S. troops in Germany and Bosnia, doctors reported.

The disease, named as one of the 'new plagues' sweeping humanity along with AIDS and ebola, can kill half its victims, if not diagnosed and treated.

Symptoms include muscle kidney failure, fever, nausea and coughing. It is spread by mice droppings and urine, which infect humans who inhale dust containing the contaminants.

The Belgian medical tearm said soldiers in ex-Yugoslavia may be in particular danger because camping out in the open encourged mice and rats.

"War and field exercises mimicking war conditions may lead to a disruption of the natural habitat of wild rodents, the carriers of hantavirus, thus putting soldiers at risk," they wrote in a letter to be *Lancet* medical journal.

Last month, Bosnian and Swedish doctors reported an outbreak of cases in Tuzla. They told the *Lancet* that more than 300 patients infected with hantavirus had been admitted to the hospital there.

"Several factors such as presence of military camps with large amounts of food stored under primitive conditions, inadequate garbage disposal, or the general breakdown of hygiene caused by water and power shortages may have resulted in a high density of rodents," the doctors, led by M. Hukic of the University Clinical Centre in Tuzla, wrote.

They said it was hard to diagnose hantavirus infection and thus hard to tell how much of a threat the disease was.

Dr. Micheal Schreiber of the Bernhard Nocht Institute for Tropical Medicine in Hamburg said hantavirus could often only be detected by complicated genetic tests, involving polymerase chain reaction.

"Since the first reported case of hantavirus infection in Germany in 1986, the number has increased every year.

Producing More Power from Waste

New technique for turning waste into electricity is claimed to be at least twice as efficient as conventional incinerators.

Depending on the type of waste material used, the Thermocrack system developed by the Wast Gas Technology (WGT) company will generate 1000-4000kwh from a tonne of waste, compared to the 500-600kwh achieved by standard incinerators.

By subjecting the waste to high temperatures of up to 1000°C in an oxgen-free atmosphere, the process converts it to a gas rather than the liquid usually produced by low temperature pyrolysis techniques. Heat is applied externally to a reactor vessel containing the waste, providing a more consistent temperature, and thus a higher efficiency, than incinerators where the temperature varies according to the material being burned. WGT says that the gas produced is ideal for use in gas engines or turbies, providing 70-110 per cent of the heating value of natural gas, depending on the raw material used.

As well as producing more gas, the Thermocrack system is said to produce 50 per cent less carbon dioxide and 60 per cent less residual waste than incinerators. WGT's Marketing Manager, Dr Kevin Whitting, says: "A typical 80,000 tonnes per annum plant should achieve an investment payback in just four years as opposed to up to 12 years for incineration." The system can handle liquid organic wastes such as waste oils and greases, or solid wastes.

WGT has built a 60kg/h pilot plant that feeds a gas engine to generate up to 55kW of power. It has processed more than 35 tonnes of waste in the plant, ranging from carpets and waxes to plastic packaging materials and sheep lanoline.

WGT, which has applied for a patent on the Themocrack technology, hopes to have its first commercial plant operating by the end of the year. At least two water companies have already expresed an interest in using the system to deal with sewage.

For more information, contact: Waste Gas Technology, Romsey, Hampshire, England SO51 0HR, Tel: 1794 518141.

Courtesy : *Spectrum*

Antarctic Ozone Hole Still Deepening

The Antarctic ozone hole, discovered 10 years ago by Britsh Antarctic Survey (BAS) scientists working at the Halley Research Station in Antarctica, is a three-dimensional phenomenon. Ozone depletion results from the presence of chlorine and bromine in the atmosphere which come from emissions of human made chemicals such as halons and methyl bromide. During the Antarctic winter, temperatures in the high atmosphere where most of the ozone is present drop below minus 80°C allowing icy clouds to form and chemical reactions to take place on their surface. At the end of the dark Antarctic winter, sunlight returns to the Antarctic atmosphere initiating further chemical reactions which destroy the springtime ozone.

Springtime values of ozone recorded at the station have fallen to less than 40 per cent of the values seen in the 1960s. The new research shows that the decline is no longer restricted to the Antarctic spring, but has extended into the summertime, increasing the amount of harmful ultra-violet radiation reaching the surface of Antarctica and its surrounding oceans.

However, BAS scientists say the good news is that the area of the ozone hole is not likely to get much bigger than it is at the moment. This is because it is contained by strong winds which circulate high in the atmosphere around the Antarctic continent, and there is not likely to be any change in this wind system.

BAS's Dr Anna Jones says: "It is only because of the restrictions of the Montreal protocol and its Amendments, controlling chlorine and promine emissions, that we can expect the Antarctic ozone hole to disappear. Even though these controls are coming into

effect, the ozone hole is likely to appear for many decades."

For more information, contact: British Antarctic Survey, Madingley Road, Cambridge, England CB3 0ET. Tel: 1223 251400. Fax: 12234 362616.

Fighting Crime with Science

An anechoic chamber—the perfect environment for unhindered acoustics—is host to the sound-testing of audio equipment at the Police Scientific Development Branch (PSDB) in southern England. This arm of Britain's Police force leads the world in the use of science against crime. As the world becomes a more sophisticated place, so do the criminals (and their crimes). Police services across the globe are constantly looking to technology and science to keep themselves up-to-date.

The world looks up at Britain's police force—a world-leader in discovering new techniques to combat crime and finding new ways of tackling the ever-increasing sophistication of today's criminals.

A shining light in this field is the PSDB, which is probably the only research and development organisation in the world specialising in the full spectrum of policing technology. PSDB has built up unrivalled knowledge which is used by the Home Office, Ministry of Defence and international law enforcement agencies.

In the past couple of years it has been developing a low-cost computer system for enhancing video recordings, involving a software package known as IMPROVE. Another breakthrough has been the cultivation of the 'DIAMOND' alarm verification system, which helps distinguish between genuine and false alarms. Both lead the way in the international market and are in regular service both in Britain and in other countries.

Perhaps the most important development has been that of the European Police Information Centre (EPI-Centre). This is a computerised bulletin in-board service that allows member police forces to exchange information and have access to a wealth of international police equipment and technology.

EPI-Centre already has users from as far away as New Zealand, Hong Kong and Europe. Dozens of applications are being received from police forces every month.

The PSDB works for the good of police services, both in Britain and other countries. What is more important is that it is paving the way to a greater understanding of how to use today's, and tomorrow's technology to beat worldwide crime.

For further information, contact: The Police Scientific Development Branch Help Desk, Tel: 1727 865 051. Fax: 1727 850 642.

Closer to Solving Organ Donor Crisis

British scientists claim they have overcome the major barrier to the use of animal organs genetically engineered for transplantation in humans.

The latest trials carried out by the Imutran company from Richmond, near London, have demonstrated that hearts from transgenic pigs beat even after 60 days when transplanted into cynomolgus monkeys. This contrasts with a previous maximum survival of only 30 hous achieved by a research group in the United States.

The Imutran test involved 10 monkeys receiving transgenic pig hearts and being given similar levels of immunosuppression as humans. Of the 10 transplants, two are currently surviving at up to 60 days and the

examination of two other monkeys, on days 34 and 35, showed that their pig hearts were normal with no signs of rejection. The average survival for the group is currently 10 days compared with control heart survival of 55 minutes.

Imutran says the success of the new trial with immunosuppressed monkeys confirms that the technology developed by the company could be the answer to the current organ donor shortage. The company now believes this technology is ready to be tested on humans and expects to begin the first trial in the UK next year.

Imutran Research Director, Dr David White, explained: "The data shows clearly that we have found a way to 'trick' the immune system of a primate into accepting a pig organ." The Director of cardiac transplantation at Papworth Hospital in Cambridge, eastern England, commented: "This research is now well advanced and we are making excellent progress in developing animal organs for transplantation—but it will be several years before they are offered routinely as an alternative to human organs. The programme of human clinical trials planned for 1996 will be a big step forward in the development of a genuine advance in transplantation."

For more information, contact: Imutran Ltd. PO Box 317, Richmond, Surrey TW9 IFU England. Tel: 181 332 2046. Fax: 181 948 5883.

Record-breaking Super Conductivity

British engineers claim to have set a new world record for the amount of current carried by a DC super conducting cable.

Working with its Italian subsidiary, the London-based BICC company has built a prototpe 1.5-m long, 102-mm diameter section of high-temperature superconductor (HTS) cable and successfully sent a current of 11,067A throught it. This is 10 times more current than that carried by a conventional 1,000 square millimetre copper cable and more than twice as much as the previous best figure for a DC superconducting cable.

Compared to traditional DC cables, HTS DC cables offer the advantge of being smaller and an ability to carry more power at lower voltages, allowing simpler AC-DC and DC-AC conversion equipment to be used at either end of the cable. BICC technology manager John McCormack says the prototype cable is the foreunner to the production of a 30-m long demonstration cable.

The prototype cable consists of two layers of flat superconducting tapes, incorporating a bismuth-type ceramic superconducting material. The tapes are made by putting the ceramic powder inside hollow silver tubes that are drawn and rolled into a flat shape. The tapes are then coiled around a tube surrounding the cryogen channel, through which liquid helium is pumped to maintain the cable at 30-40°K.

One large potential HTS market is for intergrid connections between European utilities and between Western and Eastern Europe. Such conjections could link France with Italy and Belgium, Finland with Sweden, Gemany with Norway, Italy with Switzerland and Austria, and the UK with Ireland and Norway.

For more information, contact: BICC plc, Devonshire House, Mayfair Place, London WIX 5FH. Tel: 171 629 6622.

Combating Virus Diseases of Groundnuts

Virus diseases of crops are costing farmers throughout the world millions of pounds in lost revenue, and robbing mankind of valuable food supplies. Based in Dundee, Scotland, the Scottish Crop Research Institute (SCRI) has the task of combating such viruses.

"Several of the viruses studied at SCRI are important agents of disease in developing countries," says virologist Dr Tony Murant, a consultant scientist to the organisation. "Among the most intriguing of these viruses are those responsible for the rosette disease of groundnut or peanut *(Arachis hypogaea)* in Africa."

Groundnut is an oilseed that originated in South America. It was carried by early colonisers to other parts of the world and has become the most important oilseed of the semi-arid tropics, providing a high-quality cooking oil and a wide range of confectionery products. A major source of protein for both people and animals, groundnut is an important cash crop for many resource-poor farmers in Africa, Asia and Latin America.

The SCRI, a British-government funded research body was set up in the early 1950s, originally to work on fruit problems. Its work has widened considerably over the last 45 years and it now employs some 400 people.

The Insitute's work on virus diseases of groundnut began in the late 1980s with funding from the British government's Overseas Development Administration. In this work SCRI has collaborated extensively with the International Crop Research Institute for the Semi Arid Tropics (ICRISAT).

Based in Hyderabad, India, ICRISAT also has regional centres in Africa. It is one of 16 international research stations that form a network supported by the aid-funded Consultative Group of International Agricultural Research (CGIAR).

Within the network, ICRISAT has a mandate to conduct research in the semi-arid tropics into groundnut, pigeonpea, chickpea, millet and sorghum.

Destructive Virus

Rosette disease can cause extensive damage to groundnut crops—in Africa it is regarded as the most destructive virus disease of the crop, causing losses of around $50 million a year. When it occurs in epidemic proportions, the entire crop can be wiped out.

In India, the most serious virus disease of the crop is called 'peanut clump' and causes losses estimated at $3 million a year.

Planting of resistant or immune cultivars is usually the best method of combating plant virus diseases. But no resistance is known to clump disease, and the resistance that is available to rosette occurs in long-season cultivars and has proved difficult, until recently, to transfer to short season cultivars.

Screening for rosette resistance is laborious, and 'resistant' plants can sometimes become infected under certain conditions.

To help combat rosette and clump diseases, virologist have turned to molecular biological techniques such as 'nucleic acid hybridisation'. Nucleic acid is present in all living cells.

Rapid advances in biotechnology, points out ICRISAT, make it possible to use genetic engineering techniques to introduce new forms of resistance to virus diseases into crop cultivars. These techniques are invaluable when genes conferring resistance cannot be incorporated by conventional breeding methods.

Rosette disease takes two main forms—'chlorotic rosette' which may affect the whole

plant or just some shoots, and 'green rosette' which stunts the plant's leaf growth.

Three Components

The work at SCRI has found that both forms of rosette are caused by a complex of three mutually dependent components—two 'helper' viruses and a so-called 'satellite' or ancillary.

The symptoms of chlorotic or green rosette disease are caused by different forms of the satellite, say virologists. The setellite must be present if the rosette is to survive and multiply—if it can be removed then it can be halted. Controlling the satellite is therefore the key to controlling rosette disease.

"The knowledge we are now accumulating on the molecular properties of the causal agents of groundnut rosette disease may provide important tools for the development of new forms of resistance," says Dr Murant.

Recent work with other viruses has shown, he says, that "introduction into the plant genome of DNA copies of viral nucleic acid sequences can confer resistance".

Work is now underway to develop suitable DNA copies of the nucleic acids of the satellite and of the two helper viruses.

Significant progress is also being made to combat peanut clump virus. At ICRISAT, a library has been prepared of complementary DNA clones, "covering the entire genomic range of the Hyderabad isolate of Indian peanut clump virus," according to the institute. These are currently being tested to detect all the isolates of peanut clump virus.

The SCRI provides the molecular base for this work. This has also included preparing parts of the virus genome for use in transformation experiments to add resistance into grondnut.

COURTESY : *Spectrum*

Groundwork for Potatoes' Future

Students at Writtle College, in Essex, eastern England—an international centre for land-based technology—are researching the influence of a chemical on the potato flow on a loaded roller table. The preserving liquid chemical is often either applied to potato tubers as a seed-treatment, or before they go into store. With greater pressure to reduce chemical use and to maximise the advantage of any chemical used, there is increased interest in the efficacy of the chemical's application. Here, students are pictured gathering information for their research. The chemical is applied by a nozzle (hydraulic or ultrasonic) above the rotating tubers passing underneath on a roller table.

The work was being carried out in conjunction with the BCPC (British Crop Protection Council). Results have shown that there are a number of interacting variables (for example size and shape of an individual tuber and the rotation speed of its neighbours) which influence the flow of the tuber and therefore the potential for uniform application of chemicals.

The college has at least 16 typical professional development training topics from which programmes are compiled to suit client requirements. These include mechanised protected crop production, machinery management, soil and water engineering and irrigation design, installation and management, arable and vegetable production technology, and crop protection technology. There are however, more than 1,000 modules of study available at the college.

For more information contact: Writtle College, Chelmsford, Essex CMI 3RR, England. Contact: The Director, Writtle International. Tel: 1245 420705 Fax : 1245 420456.

Towards a Super-Efficient Solar Cell

For many decades solar power has been hailed as possible cure to the world's energy crisis. Solar cells convert sunlight directly into electrical power and are attractive because of their versatility, low maintenance cost and minimal environmental impact. They are already the simplest and most effective means of generating power for a wide spectrum of application ranging from setellites to the needs of isolated communities. They are particularly suitable for developing countries because many elements of a stand alone photovoltaic (PV) system consist of low to medium technology, which can be produced and maintained at point of use.

Current research cells, however, are nearing the fundamental efficiency limit for designs depending on a single semiconductor. Novel approaches which have potential for exceeding this limit include the tandem cell which uses two components made from different materials, and recently the quantum well solar cell (QWSC).

In a solar cell, incident light with energy greater than that of the semiconductor bandgap excites electrons or 'holes' in a p-type semiconductor) into a state where they are mobile and can set up an electrical current which allows power to be extracted from the device. The excited electrons or holes are known as carriers.

Unfortunately all light with energy below the threshold bandgap energy passes through the cell. Furthermore, a sizeable fraction of the absorbed energy is lost as heat. This is because most of the carriers absorb more than enough energy to cross the threshold. These energetic carriers rapidly lose the excess energy in collisions and raise the temperature of the cell in a process known as thermalisation. These loss mechanisms limit the fundamental efficiency of a single bandgap solar cell to about 31 per cent.

Researchers in Dr Keith Barnham's solar cell group at Imperial College in London have been investigating a new QWSC design which attempts to overcome these two losses. This contains very thin layers of a lower handgap semiconductor embedded in the current bearing active region of a conventional cell. These layers are known as quantum wells (QWs) because electrons are sufficiently confined to show quantum behaviour.

The QWs enhance efficiency in two ways, First, they increase the absorption of the QWSC. Secondly, the QWSC exploits the heat generated by the high energy carriers thermalising down to the higher bandgap. The carriers generated in the wells undergo the reverse process of escaping out of the quantum wells to higher energy states. This mechanism extracts heat from the system and convert it to electrical power, partly counteracting the thermal losses described above.

Output Voltage

The Imperial College group has recently shown that the output voltage of the cell is greater than that delivered by a single bandgap cell made from a semiconductor with the quantum well effective bandgap. The QWSC may deliver more power than the single bandgap cell if it can be tailored to produce the same short circuit current at a higher voltage.

With financial backing initially from the Greenpeace Environmental Trust, and later from Britain's Engineering and Physical Sciences Research Council and its associated Clean Technology Unit, the early studies of the QWSC concentrated on demonstrating I_{sc} enhancement and effective carrier escape

from the wells at room temperature in the extensively studied $Al_x Gal_x As/GaAs$ material sysem.

The group compared the I_{sc} and efficiency as a function of incident light wavelength (spectral response) of cells made from $Al_{0.3} Ga_{0.7} As$. The QWSC had 30 periods of GaAs in the active region while the control was identical but without QWs. Experiments showed that the I_{sc} in the QWSC was 2.5 times that produced by a control cell. The open circuit voltage had dropped, but only by about 10 per cent. Theoretical modelling response showed that nearly all this I_{sc} increase is contributed by the wells.

Photoconductivity and photoluminescence studies of the cells showed that, at the maximum power point at room temperature, nearly 100 per cent of the carriers generated in the wells escaped. A sample grown with 50 periods of QWs was measurred to be 14 per cent efficient compared to an estimate of 9 per cent for a control cell.

The next step for the Imperial College group was to establish that the open circuit voltage of a QWSC is higher than that of a control cell made from a material with the QW bandgap. If this were not the case, the QWSC would be equivalent to the control and would be subject to the same efficiency limits.

The group has investigated four materials systems. These are Al_xGa_{1-x},As/GaAs InP/InGaAs, GaAs/InGaAs and Inp/InGap. A voltage enhancement has been experimentally verified in three of them. The remaining system (GaAs/InGAAs) cannot be tested since no InGaAs control can be grown. These two results have effectively demonstrated that the fundamental limits to the efficiency of solar cells can be stretched. The extend and feasibility of any efficiency increase, however, requires intensive research into materials and cell design.

Efficient Techniques

Work in Dr Barnham's group has now progressed to designing an efficient QWSC in the systems described above. The AlGaAs/GaAs suffers from poor electronic transport properties at high aluminium fractions which degrade the performance of the conventional part of the cell. These can be minimised with a technique known as compositional grading in which the bandgap of the top layer of the cell is increased towards the surface. This allows more light to reach the efficient active layer and encourages carriers near the top of the cell to migrate down the bandgap gradient towards the junction. Significant spectral response improvements have been observed in conventional and QWSC cells of this design.

Another technique well suited to the QWSC is coating the back of the cell with a mirror. Although the QWs are nearly 100 per ment efficient in converting absorbed light into current, only 50 have been included to date for technological reasons. As a result, a typical QW system might only absorb an average of 45 per cent of the incident light below the higher bandgap.

The mirror on the back of the cell can then reflect the remaining 55 per cent of light back through the cell for a second pass. Conventional thin film cells also employ this technique but with less gain because they absorb much more light on the first pass.

The QWSC shows promise for a range of application because of the ease with which its output current can be tuned by varying the QW current contribution, the use of thermal heat, and the output voltage enhancement. The poor material's properties of $Al_xGa_{1-x}As$ make it an unlikely candidate for a good solar dell in its own righi. However, it can be grown with an unrivalled range of QW depths which makes it easy to tune its

QW current contribution. This might make it attractive as the higher bandgap component of a tandem system. Conventional tandem designs have often experienced problems with matching the current output of the two component cells.

The fact that carriers in the well exploit waste heat to thermalise out of the wells make the QWSC particularly attractive for concentrator applications. Conventional cells lose efficiency with increasing temperature, and concentrator system using these cells must rely on cooling systems to minimise this problem. The QWSC is expected to gain in efficiency with increasing temperature or at least to lose efficiency more slowly than conventional cells if the wells are deep enough to exploit this phenomenon. The InP/InGaAs system is atractive in this respect since the wells are particularly deep.

In short, the complex consequences of the novel operational principles of the QWSC are expected to be useful in a range of different areas. Although the question of whether they can in practice break through the fundamental efficiency limits is still a matter of debate, they may at least facilitate the design of cells approaching these limits.

COURTESY : *Spectrum*

Climate Change Could Pose Substantial Risks to Human Health

The sustained health of human populations requires the continued well-being of the Earth's natural systems. Climate change may create environmental problems as well as aggravate existing ones. Human health could be affected both directly and indirectly, according to a recent report by the Intergovernmental Panel on Climate Change (IPCC).

The IPCC, composed of experts from more than 50 countries, points out that the direct impact upon human health such as dealth and injuries caused by heat waves, hurricanes and other extreme weather events is reasonably predictable because empirical scientific data is widely available. The effect of an increase in exposure to ultraviolet radiation upon skin cancer and eye disorders such as cataracts has also been well documented.

But the indirect impact of climate change, although potentially as devastating, is less predictable. Changes in the climate and weather create new breeding grounds for infectious microbes as well as for the insect and animal hosts that carry them and spread disease. The infiltration of salt into water tables, drought, new storm patterns and rising sea-levels all contribute to the spread of water-borne disease and reduce the availability of safe drinking water. Climate change can reduce agricultural productivity, resulting in famine or nutritional deficiencies that impede resistance to infections.

Climate shifts that affect the health of complicated ecological relationships and habitats pose a complex challenge for establishing a scientific model. IPCC's report states that while predictions can be derived from complex models, the further the future scenarios extend beyond the boundaries of the empirical base of those models, the more likely it is that the actual health outcomes would include surprises.

Twenty years ago the human immunodeficiency virus (HIV) that cause AIDS was an obscure family of African viruses. Today AIDS is killing millions. And would any scientific model have been able to predict the re-emergence of cholera?

The extent and rate of climate change, as projected by the IPCC for the coming century, would lie outside the range of recorded

human experience. Much of the impact on human health is therefore uncertainl, some of it unforeseeable.

A US Government inter-agency group was convened last year to consider the global threat of emerging and re-emerging infectious diseases. The working group was established under the aegis of the Committee on International Science, Engineering and Technology Policy (CISET) of President Clinton's National Science and Technology Council.

According to a CISET report, infectious microbes have a remarkable ability to evolve, adapt and develop resistance to drugs. Diseases that we once thought to be under control have re-emerged sometimes in more virulent forms. Around the globe there is a resurgence of cholera, malaria and yellow fever. Dengue fever and hantavirus are appearing in the states of New Mexico, Minnesota and Virginia. Drug resistant pneumonia and tuberculosis are increasing. The ebola virus has appeared again in Africa.

The reasons for the sharp increase of many infectious diseases are complex and not fully understood. Population shifts and population growth; changes in human behavior, urbanization, poverty and crowding changes in ecology and climate, the evolution of microbes; inadequacy of public health infrastructures; and modern travel and trade have all contributed.

The report points out that the ease of modern travel creates many opportunities for a disease outbreak in remote areas to spread to a crowded urban area. Dietary habits and food handling, personal hygiene, risky sexual behaviour and intravenous drug use can contribute to the emergence of disease.

Human encroachment on tropical forests has brought populations into close contact with insects that carry malaria, yellow fever and sometimes unknown infectious diseases.

A diverse group of experts got together at the National Academy of Sciences in Washington D.C. late last year to exchange information and develop strategies designed to assess and combat the potential health consequences triggered by climate change. They recommended that an effort to monitor health and environmental data should be international in scope, should involve inter-agency cooperation and exchange of information, provide training for health personnel, improve response ability and require centralized sites for the processing and evaluation of data.

The panel stressed that the research challenge of climate change is to not only better understand the specific disease processes that are susceptible to climate variables but also to integrate knowledge from several disciplines to create a better understanding of complex ecosystems.

For example, the council believes that climatologists must understand the forces that affect storms and precipitation. They also must work with entomologists to define exactly which aspects of climate are most important for parasite reproduction. The entomologists in turn must interact with social scientists to associate increased parasite reproduction with changes in human behavior patterns, which may affect exposure and susceptibility.

Rising Temperatures

Long-term climate changes caused by global warming could trigger hundreds of thousands of additional deaths each year from tropical diseases like malaria and yellow fever, scientists report.

Using global climate models, they also point to the possibility of additional deaths in industrialized countries from a rising in-

cidence of summer heat waves. Earlier this year, over 500 people died in Chicago, a major U.S. city, during a stifling five-day heat wave that included temperatures as high as 41 degrees celsius.

But researchers expect global warming to have its most deadly impact on developing countries, predicting an increased prevalence of infectious diseases as mosquitoes and other pests expand their ranges.

According to Dr. Paul Epstein, professor of tropical medicine at the Harvard School of Public Health, a warmer climate is believed to be responsible for Aedes aegypti mosquitoes—prime carriers of both dengue and yellow fever—extending their range higher into the mountains than ever before in regions of Costa Rica, Colombia, India and Kenya. The mosquitoes are being found above 2,000 metres, whereas previously they were limited by temperature to altitudes below 1,000 metres.

Researchers also report that mosquito species that host yellow fever parasites have established themselves in the southeastern United States. The occurrence of a yellow fever outbreak in the city of New Orleans would sicken 100,000 and kill 10,000 people, according to the National Institute of Medicine.

Epstein's investigations also reveal evidence that warmth is extending the reach of malaria.

"In Africa you're seeing malaria carrying mosquitoes higher up in the mountains in Kenya and threatening Nairobi, whereas that was not a place you'd get malaria in the past," Epstein says. "This seems to be happening over the last two decades—since the mid 1970s things have begun to change at a rapid rate."

Mechael Loevinsohn, an ecologist at the International Development Research Centre in New Delhi has linked a one-degree-Celsius increase in the average temperature in Rwanda in 1987 to 37 per cent rise in the incidence of malaria that year. Especially vulnerable were mountainous areas of Rwanda in which malaria had been rare, according to Loevinsohn's findings.

Researchers have also linked the warm spells and heavy rains caused by El Nino—a cyclical warming of the tropical Pacific Ocean that affects global climate—to outbreak of illness and infectious disease.

Epstein and microbiologist Rita Colwell, president of the Maryland Biotechnology Institute, suggest that El Nino may have contributed to a cholera outbreak that caused thousands of deaths in 19 South American countries in 1991. The scientists believe the El Nino conditions stimulated the growth of plankton that harbor the cholera bacterium. They have also collected data suggesting a similar link between El Nino and recent cholera outbreaks in Bangladesh.

In Zimbabwe and western Mozambique, periods of drought associated with El Nino have regularly led to major infestation of rats, which are carriers for a number of pathogens.

Climatic disruptions in the form of floods and drought are believed to have been indirectly responsible for an outbreak of hantavirus respiratory illness in the southwestern United States in 1993. Studies have linked emergence of the disease to a sudden increase in deer mice, which are carriers of the hantavirus, following heavy rains from an El Nino warming episode.

The rains produced an abundance of food for the mice, while the drought had eliminated many of their predators, leading to ten-fold increase in the number of deer mice over a one-year period. As of June 1995, 106 cases of the unusual disease had been reported in 23 states. Half of those cases were fatal.

Scientists report that warming in the

deep oceans may be driving El Nino conditions, which have occurred more frequently and persisted longer than usual since 1980.

"In just the last six to eight months we've become aware of warming in the deep Indian, Pacific and Atlantic Oceans," Epstein says. "Even under both polar ice caps there's significant warming of one degree Celsius over the last decade. We' ve been in a consistent El Nino pattern for the last five years...and it reflects the warming that's in the oceans. This is a definite sign of global warming."

Epstein believes that the more than 500 people who died during a recent heat wave in Chicago is an example of the kind of health hazard that can result from global warming.

"I think the entire summer should be a wake up call to us," he says. "No scientist will say that one heat wave is proof of anything. But we are in one of the longest heat waves that we have ever seen in this century, and it's entirely consistent with what we believe is happening with increased greenhouse gases and increased warming."

Climatologists at the University of Delaware, using a global warming model, found that an increase of two to four degres Celsius in average temperature would likely double the number of unusually hot days during a typical summer. They found that this, in turn, could increase the number of heat-related deaths per summer in New York City from 320 to at least 880, and in Cairo, Egypt, from 281 to 1,125.

While most scientists cite increasing evidence that the Earth is warming up—the 1980s was the warmest decade on record—it still has not been determined whether this signals global warming caused by industrial emissions of carbon dioxide and other gases or a temporary rise in temperature due to climate variation.

As for the health threat posed by global warming, Epstein recommends increasing global surveillance of infectious diseases.

"We also need to integrate health surveillance with environmental monitoring so we can anticipate and sometimes even predict where it's going to be hot and rainy so we know where malaria is going to surge," he says.

Ultimately, health officials may have to reevaluate their notion of disease, according to the Harvard Working Group on New and Resurgent Diseases.

"We must see disease as the outcome of multiple conditions arising from changes not only within cells, but around the globe, including changes in climate and economic patterns," the group concludes in a recent report.

COURTESY : *Science*

Scientists Say Humans Probably Increased Global Temperature

An international group of scientists has concluded for the first time that human activities such as the burning of coal and oil to produce electricity probably are warming Earth and may produce dramatic climate changes.

Until now, scientists advising the more than 100 governments that have ratified a treaty aimed at minimizing climate change have said they could not tell whether the warming of the planet the past 100 years is due to the growth of modern industry and agriculture or simply natural variations in the interactions of sunlight, the atmosphere and the oceans.

"It is increasingly becoming evident that human activities are causing a warming but it is still a preliminary conclusion, not that definite, "Ebby Anyamba, a Kenyan scientist, said in an interview. She is now working at

the U.S. National Aeronautics and Space Administration.

She and an international team of scientists from around the world led by Benjamin Santer of the U.S. Lawrence Livermore National Laboratory, came to that conclusion in the draft of a report prepared for the Intergovernmental Panel on Climate Change (IPCC).

The answer to the question whether the 0.3 to 0.6 Celsius warming of Earth the past 100 years is due to natural variability or human activities could affect the future of economic growth in developing countries and the level of economic well-being in the developed world.

That is because several IPCC reports the past five years and the current draft report calculate that the average temperature of the globe will increase between 0.8 and 4.5 degrees Celsius and sea level 10.1 to 1.2 metre by the year 2100 if emissions of greenhouse gases—which warms Earth—are not curbed.

"These projections indicate changes more rapid than any experienced in the last 10,000 years, the current interglacial when modern society has evolved," the draft report states.

The burning of coal, oil and wood, the cutting of forests, rotting rice paddies and by-products of the digestion process in insects and livestock release various kinds of gases that prevent heat from Earth escaping into space.

Business groups and many governments in the industrialized world have argued that it made no sense to disrupt their economies by reducing greenhouse gas emissions while scientists were unsure why there has been a warming so far and until computer models looking into the future become more sophisticated.

Developing countries have been arguing that they did not create the warming of the last century and need to industrialize now to create economies large enough to provide a decent standard of living for their big and growing populations.

"The draft report indicates that our governments should plan for long-term reductions. Emissions should come down well below current levels." Michael Oppenheimer, an atmospheric scientist at the Enivronmental Defense Fund, said in an interview. He has been aware of the work the past year of the scientists preparing the draft report.

A major reason for the shift of opinion among scientists working on the report is the finding that many studies now show a similarity between measurements of temperature and various other climate data and the figures churned out by computer models that look into the past as well as make projections for the future.

"Overall, the best evidence to-date suggests that global mean temperature changes over the last century are unlikely to be entirely due to natural causes, and that a pattern of climatic response to human activities is identifiable in the climatological record," the report stated.

Dramatic changes in Earth's temperature and sea levels would harm developing countries the most because they have less than industrialized countries of the technology and financial resources to build protections against some of the effects, according to the draft report.

Some of the effects of higher temperatures, according to the report, are

— greater warming over land masses than oceans, with the largest increases coming over northern areas in the winter;
— stronger monsoons in South Asia;
— more rain in general, leading to more floods in some areas;
— longer and more severe droughts in areas now prone to such disasters;
— decreases in winter days below freezing.
— increases of about 20 per cent in the num-

ber of cases of malaria, that is an extra 50-80 million, and river blindness, and extra 3.5 millions cases.

15 to 95 Centimetre Sea Level Rise Foreseen by 2100

About 1,000 scientists from more than 70 countries have concluded after two years of study that emissions of greenhouse gases will warm Earth's temperature from 1 to 3.5 degrees Celsius and increase sea levels 15 to 95 centimetres in the next 100 years.

These findings by scientists from government industry and environmental groups involved in the study sponsored by the Intergovernmental Penel on Climate Change (IPCC) are based on more precise measurements and models and are lower than the conclusions of a 1990 IPCC report, assert U.S. scientists who worked on the current report.

"The basic finding is that tropical areas are most vulnerable" to the harm that higher temperatures and sea levels would produce in agriculture, land use and human health, according to Robert Watson, associate director for environment in the White House Office of Science and Technology policy.

If sea levels rise about one metre—the worst-case scenario—about one per cent of Egypt, 6 per cent of the Netherland, 17.5 per cent of Bangladesh and 80 per cent of the Majuro Atoll in the Marshal Island would be under water by the year 2100, according to the IPCC report.

Temperatures and sea levels would continue to rise after 2100 but at a slower rate as such greenhouse gases as carbon dioxide, produced by the burning of coal, oil and wood and by logging of forests, continued to accumulate in the atmosphere, the report said.

Agricultural production would probably ramain high in developed countries because they have the money to increase irrigation or fertilizer use, which many lesser developed countries might not be able to do, Watson said.

In addition, some crops would have to be grown north of their present range because of higher average temperatures. Similarly, forests might disappear from much of the temperate zone where they are now and grow much farther north in Canada and Siberia.

The report does not estimate how many more people might go hungry, largely because the computer models projecting the likely changes in climate are not accurate enough yet to pinpoint how a particular region would be affected, Watson said.

Malaria now exists in region's housing about 40 per cent of the world's population. That number would rise to 60 per cent if temperatures increase 3.5 degrees—the worst-case scenario.

Jae Edmonds, chief of the climate change group at a Batele Corporation laboratory, said that current energy-efficient technology in industrialized countries could reduce greenhouse emission 10 to 30 per cent at little or no cost.

But far more drastic measures would be needed to prevent any climate change, he said. He said there would have to be an immediate 60 per cent reduction in emissions to prevent further concentration of greenhouse gases in the atmosphere, a step that would disrupt all economies in the world.

SCIENCE RELATED VALUES

Curiosity, quest for knowledge, objectivity, honesty and truthfulness, courage to question, systematic reasoning, acceptance after proof/verification, open-mindedness, search for perfection and team spirit are some of the basic values related to science. The processes of science, which help in searching the truth about nature and its phenomena are characterised by these values. Science aims at explaining things and events. Therefore to learn and practise science :

* **Be inquisitive about things and events around you.**
* **Have the courage to question beliefs and practices.**
* **Ask 'what', 'how' and 'why' and find your answers by critically observing, experimenting, consulting, discussing and reasoning.**
* **Record honestly your observations and experimental results in your laboratory or outside it.**
* **Repeat experiments carefully and systematically if required, but do not manipulate your results under any circumstance.**
* **Be guided by facts, reasons and logic. Do not be biased in one way or the other.**
* **Aspire to make new discoveries and inventions by sustained and dedicated work.**

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school science

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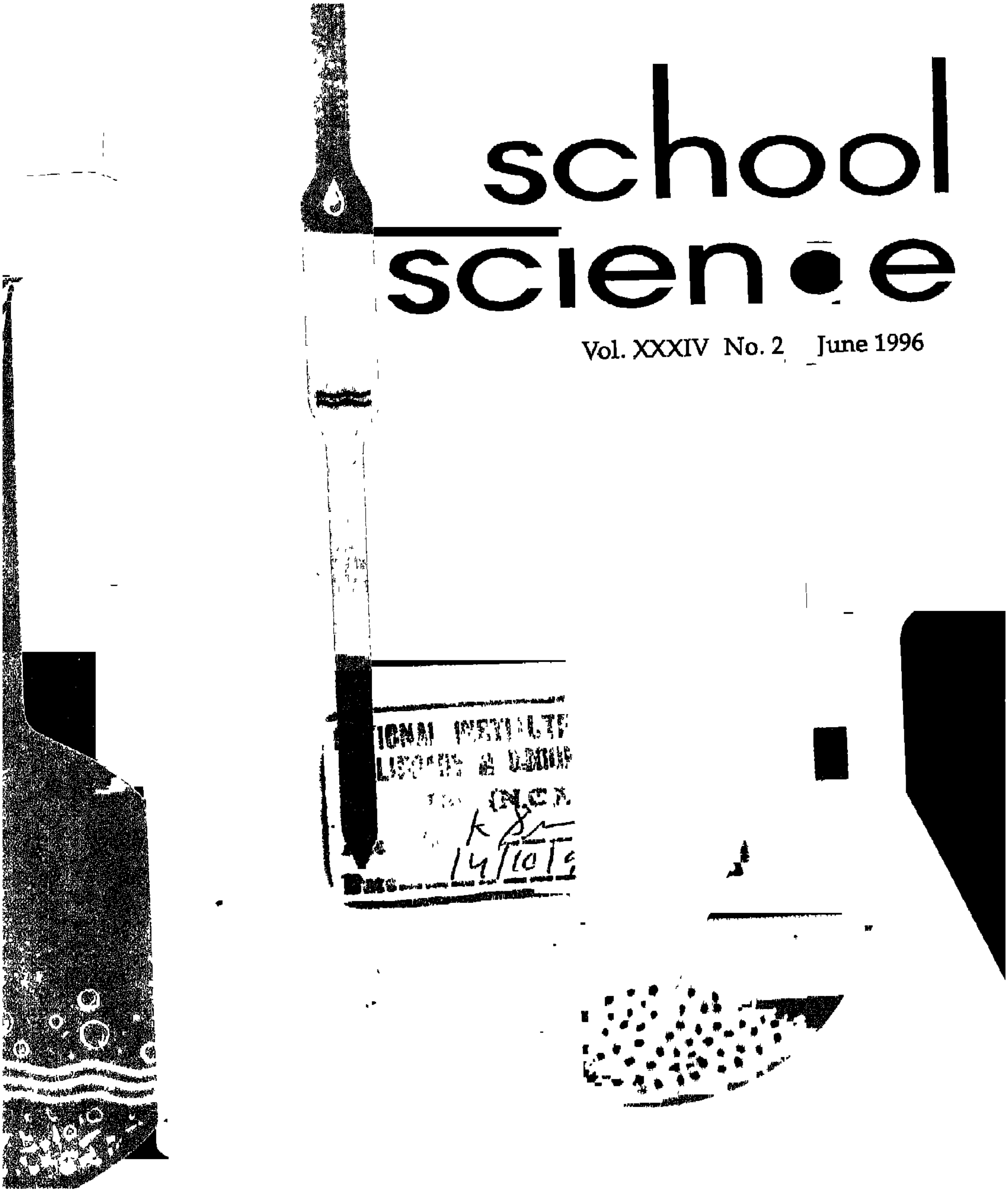

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NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

SCHOOL SCIENCE is a journal published quarterly by the National Council of Educational Research and Training, New Delhi It aims at bringing within easy reach of teachers and students the recent developments in science and science methodology, and serves as a useful forum for the exchange of readers' views and experiences in science education and science projects.

Articles suitable to the objectives mentioned above are invited for publication. An article sent for publication should normally not exceed ten typed pages, and it should be *exclusive* to this journal. Illustrations should be drawn with pen and indelible Indian ink. Photographs (black and white), at least of postcard size, should be on glossy paper, and should be properly packed to avoid damage in transit.

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TO OUR CONTRIBUTORS

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Gravity in Action

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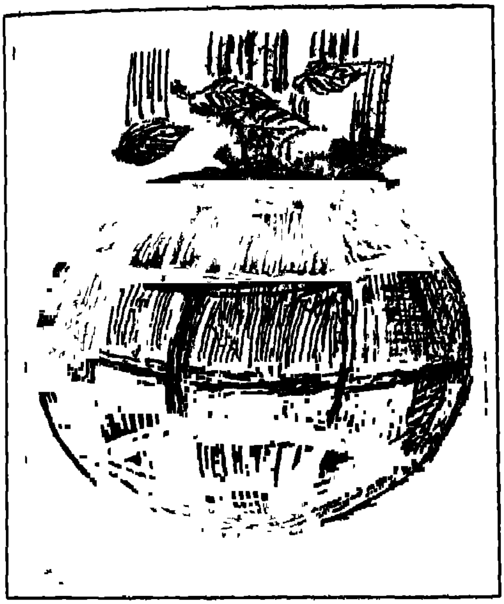

You might have wondered why objects when released from a certain height fall down on the ground. When you throw a ball up it does not continue going up, but soon comes to a halt at a certain height and then begins to fall. As it falls it gains speed. If we release two bodies of different masses from a certain height, say the roof of a house, will they reach the ground at the same time or at different times? This question is not at all easy to answer. If you drop a piece of paper and glass marble from a certain height, the marble will hit the ground much before the slip of paper reaches there. Even if we take objects of similar shape the answer is not easy. You might have noticed that larger rain-drops fall much faster than smaller ones — though all drops are spherical in shape. Even if we take two identical spheres, say one made of lead and the other of wood, can one say that they will fall together when released from a height simultaneously. The great Greek Philosopher Aristotle (384-322 B.C.) firmly believed that heavier objects fall faster than lighter objects of identical shape. No one questioned his judgement for many centuries and probably no one ever tried to verify whether what Aristotle said was correct.

The great Italian scientist Galileo Galilei (1564-1642) was amongst the first who wanted to experimentally test many of the ancient beliefs. He is rightly regarded as the father of modern scientific method. It is said that he dropped two identical spheres, made of different materials — one heavy and another light — from the top of the Leaning Tower at Pisa. He found that both the spheres reached the ground at the same time. This was a great discovery — *objects fall to the earth at the same rate independent of their mass.* You will note that this simple fact which we now take for granted is not at all obvious and took many centuries to get established.

We earlier considered examples of a glass marble and piece of paper and also rain drops of different sizes. These are *observed* to fall at different rates. How do we reconcile Galileo's observa-

tions with ours? In the case of certain objects like paper, feathers, parachutes or small spheres like rain drops air plays a dominant role and changes the rules of falling bodies.

Kepler's Laws

The great Danish astronomer Tycho Brahe (1546-1601) is unparalled in the history of science. With naked eyes and instruments designed and built by him for measuring angles, he spent his entire life making precise measurements of the positions of celestial bodies. He accumulated accurate and vast data. As he did not have much talent in mathematics he could not himself make much use of the vast data. His Austrian assistant Johannes Kepler (1571-1630), an outstanding mathematician, analysed the available data. He provided confirmation for the Copernican model of the solar system, according to which the planet revolved around a stationary sun. Kepler formulated three laws for planetary orbits. These are :

1. Planets revolve round the sun in elliptical orbits.

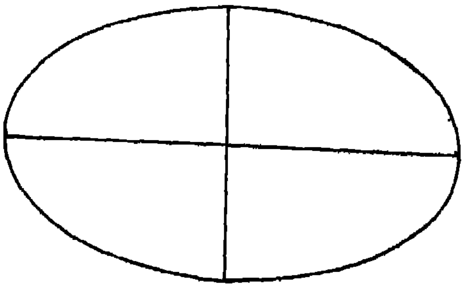

Fig. 1

2. An imaginary line drawn from the sun to the planet sweeps equal area in equal time (Fig. 2a, b).

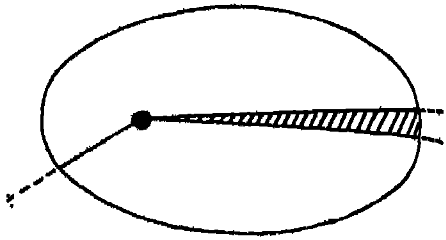

Fig. 2a

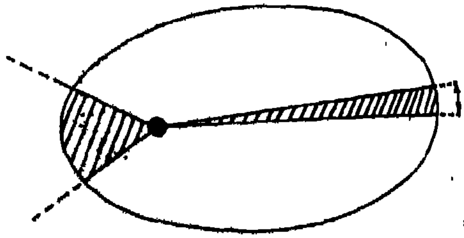

Fig. 2b

3. The squares of the times required by the planets for a complete orbital revolution about the sun is proportional to the cubes of their average distances from the sun. (See Table 1.)

These laws were discovered from observed data and no justification could be provided for them.

TABLE 1

Planet	T (Period in years)	R (Distance from the sun in terms of earth sun distance)	T^2	R^3
Mercury	0.241	0.387	0.058	0.058
Venus	0.615	0.723	0.378	0.378
Earth	1	1	1	1
Mars	1.881	1.523	3.276	3.533
Jupiter	11.862	5.203	140.7	140.85
Saturn	29.46	9.564	867.9	874.8

Law of Gravitation

The year Galileo died, Isaac Newton (1642-1727) was born in England. He is ranked amongst the world's top scientists for all times. He contributed in a major way in many fields of science. You may have heard of the three basic laws of motion which go by his name. He demonstrated that white light is composed of seven colours. He was one of the persons to develop the whole field of calculus in mathematics. He also gave the law of universal gravitation. We will discuss this last topic in some detail here.

There is a story often told about Newton. It is said that once while he was sitting in a garden, he saw an apple fall from an apple tree. This set him thinking as to why things fall to the earth and not fly away. He conjuctured that just as the earth pulls the apple towards itself, all matter must attract other matter. But what should be the law of attraction? How does the attraction depend upon the masses of the bodies and how does it depend upon the distance between them? It was the genius of Newton that from a simple observation of a falling apple and the laws of Kepler, that were known to him, he obtained, what we now call as Newton's law of universal gravitation. According to this law two mass M_1 and M_2 attract each other with a force proportional to the product of their masses and inversely proportional to the square of the distance R, separating them. That is, the force of attraction F is

$$F \propto \frac{M_1M_2}{R^2} \text{ or } F = G\frac{M_1M_2}{R^2} \quad \text{....(1)}$$

where G is the constant of proportionality and is called the gravitational constant. If F is measured in newtons, M in kilograms and R in metres, then

$$G = 6.67 \times 10^{-11} \longleftarrow m^3/kgs^2$$

Before we look into the consequences of this law, let us see what impact it had on the thinking of the times.

As we mentioned above, experimental science, in the modern sense, started with Galileo, only a few decades before Newton. A few laws of Nature had been discovered from observations made in the laboratory or outside. There were no reasons to assume that the laws so discovered would also hold in very different situations. Hence, when Newton showed that Kepler's third law followed from his law of gravitation, it has great impact on the thinking of the times. It established that the laws discovered by man from his observations on the earth also applied to the heavens. It is this which made the entire universe amenable to study by man.

Falling Bodies

Let us now come back to the problem with which we started, that of falling bodies on the earth. Let the radius of the earth be R and its total mass M. If we have a body of mass m close to the earth's surface, the force exerted on it by the earth will be

$$F = \frac{GMm}{R^2} = g\,m \quad \text{....(2a)}$$

$$\text{where } g = \frac{GM}{R^2} \text{ or } M = \frac{gR^2}{G} \quad \text{....(2b)}$$

This force is directed towards the centre

of the earth. Here g is a constant. Thus the force of attraction on a body of mass m, near the surface of the earth is directly proportional to its mass m. We now involve Newton's second law of motion : The force acting on a body is equal to the product of its mass and its acceleration, and is directed along the acceleration written mathematically it is

$$F = m\,a \qquad ...(3)$$

where a is the acceleration. If we are dealing with the earth's force of gravitation then from equations (2) and (3) we have

$$F = g\,m = m\,a \qquad ....(4)$$

i.e. $a = g$

The quantity g is called acceleration due to gravity. Eq. (4) implies that the acceleration experienced by any body falling under gravity is independent of the body's mass. Hence all falling bodies fall with the same constant acceleration, g.

It is important to note that we have nowhere talked of the atmosphere and the influence of air on falling bodies. Eq. (4) holds only when the resistance offered by air to a falling body can be neglected.

The value of g can be determined by studying falling bodies. It is nearly

$$g=9.8\ m/s^2$$

The value of g varies slightly from place to place on the surface of the earth, since it is not a perfect sphere.

We note from Eq.(2b), that if we can find the radius of the earth, knowing g and G, we can easily find the total mass of the earth. The radius of the earth had already been determined by the Greeks by measuring the lengths of shadows cast by objects, at two different cities whose distance was known. The presently accepted value of earth's radius is 6371.02 km. Taking roughly

$R = 6.4 \times 10^5$, we find

$$M = \frac{gR^2}{G} = \frac{9.8 \times (6.4)^2 \times 10}{6.67 \times 10^{-11}} \text{ km}$$

$$= 6 \times 10^{24} \text{ km.}$$

Did you even think what could be the mass of our earth and how it could be estimated? Is it not a wonder that by studying falling bodies, we can estimate its mass. It is instructive to determine the average density of the earth. Since we know its mass and its radius, it is easy to calculate the density.

$$\text{Density } P = \frac{\text{Mass}}{\text{Volume}}$$

$$= \frac{\text{Mass}}{4/3R^3} = \frac{3gR^2}{4GR^3} = \frac{3g}{4GR}$$

$$= 5.5 \times 10^3 \text{ kg/m}^3$$

You know that the earth rotates about its axis once in 24 hours. This is what causes day and night. We live on the surface of the earth. What is the speed with which this surface is moving? This would be the speed with which we go round, without even being aware of it (Fig. 3). Let us calculate this speed. It will be

$$\text{Speed} = \frac{\text{Circumference}}{\text{Time of one rotation}} = \frac{2\pi R}{24 \text{ hours}}$$

$$= 0.47 \text{ km/s}$$

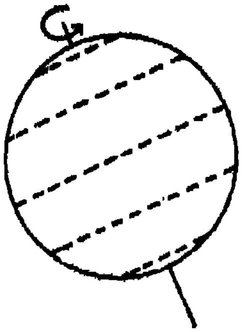

Fig. 3

i.e. nearly half a kilometre per second or 1800 km/hr. This is almost the speed of present day jet planes.

If we are travelling at such a high speed sitting on a rotating sphere, why are we not thrown off into space? The answer is that the attraction due to gravity is much stronger than this and keeps almost tied to the ground. Can we set ourselves free from this grip of the earth? Yes, we can. If the kinetic energy of a body is equal to its potential energy on the surface, then it can escape from the gravitational attraction. We can write the condition for a body of mass and speed as

$$\frac{1}{2} mv^2 = \frac{GMm}{R}$$

$$\text{or } v^2 = \frac{2GM}{R} = 2\,gR \qquad \ldots (5)$$

This gives $v = \sqrt{2\,gR} = 11.2$ km/s.

If a body should have a speed equal to or greater than about 11.2 km/s, it will be able to get away from the earth's attraction. If the speed is lower, it will go up, stop and come down again.

The Moon

Unlike some large planets like Jupiter and Saturn which have a large number of moons (12 and 9 respectively), our earth has only one, but what a beautiful one ! It goes round the earth in 27.3 days. The period of rotation about its own axis is also the same. This is why from the earth we see only *one* face of the moon. The other side is hidden from us. (We now have photographs of the other side too, taken by satellites which went round the moon). The moon goes round the earth because of its gravitational attraction.

Consider a tall tower over the surface of the earth. If a ball is thrown horizontally from the top of the tower, it will gradually come down and fall down on the surface of the earth, say at A (Fig. 4).

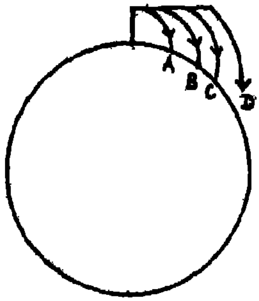

Fig. 4

If we throw another ball with greater horizontal speed, it will fall at some point B, farther from the base than point A. If we were to throw a ball with such a speed that the surface of the earth bends by as much as the ball falls towards the earth, then it will continue to

move in a circular path without ever falling on the surface. *The moon too is falling towards the earth* like any other object, but since it also has a tangential speed, it fails to hit the ground, and keeps moving in a circular orbit.

Since we know the period of revolution of the moon around the earth, we can calculate its distance from us. Let M be the mass of the earth and R the distance of the moon from the earth, then

$$\frac{GMe}{R^2} = \frac{v^2}{R} = \frac{(2\pi R)^2}{T^2} = \frac{1}{R} = \frac{4\pi^2 R}{T^2} \quad ...(6)$$

Here T is the period of revolution of the moon around the earth. This equation leads to

$$R = \sqrt[3]{\frac{GMeT^2}{4\pi^2}} \quad \text{or } T = \sqrt{\frac{4\pi R^3}{GMe}} \quad ...(7)$$

(Note that Eq.(7) is the mathematical form of Kepler's third law). Substituting the values of G Me and T in Eq.(7) w get

$$R = 383000 \text{ km}$$

which is nearly 60 times the radius of the earth. (The more correct value is 384400 km)

Eq.(7) will also hold for artificial satellites. For example we can calculate the height above the earth's surface where a geostationary satellite is established. Since these satellites appear stationary with reference to a particular place directly below on the surface of the earth, they must also revolve round the earth with a period of 24 hours. Hence using Eq.(7) we find. R = 42200 km. Subtracting from this a distance equal to the radius of the earth (≈ 6400 km), we get 35800 km as the height of a geostationary satellite from the earth's surface (Fig. 5).

Fig. 5

Let us now calculate the value of g on the surface of the moon. Using the parameters of the moon given in Table 3 and using Eq.(2b); we find

$$g_{moon} = 1.66 \text{ m/s}^2$$

which is nearly 1/6th of the value of g on the earth.

TABLE 2

Earth
mass = 5.976×10^{24} kg
mean radius = 6371.02 km
(rounded off to 6400 km)
Moon
mass = 7.35×10^{22} kg
mean radius = 1720.2 km
Distance of the earth from the sun = 149.6×10^6km
Distance of the moon from the earth = 0.3844×10^6km

This means that moon's hold on objects on its surface is much weaker than that of the earth. For the same effort, a man may be able to jump six times the height he jumps on the earth.

The escape velocity (Eq. 5) on the surface of the moon is

$$v_{moon} = 2.42 \text{ km/s}$$

which is almost 1/5th of what it is on the earth.

Centre of Mass

In deriving Eq.(7) for the moon going round the earth, we had to define the distance between these two large objects. From which point on earth to measure this distance and up to which point on the moon? Law of gravitation implies that there should always be *one point* in everybody at which we can take its total mass to be concentrated, so far as its interaction with other objects is concerned. This point is called the *Centre of mass*. For a uniform sphere, the centre of mass is at its centre.

Let us considering a simple but interesting example. Take a stiff card and draw on its (or trace) the figure of the bird shown in Fig 6a..On both A and B place a 50 paise coin and attach it there with the help of cellotape. Turn the bird up-side down so that the 50p coins are now on the lower side. You can now balance the bird from its beak on your finger tip (Fig. 6b). This is because the centre of mass of the object is near its beak.

Consider a small table lying on a flat surface whose inclination to the horizontal can be varied. The force of gravity of the earth acts on the centre of mass of the table along a line perpendicular to the earth's surface (and pointing towards the centre of the earth). If this line intersects the surface on which the table is resting (Fig.7) at some point inside the area defined by the four legs. The table will be stable. However, if the point of intersection lies outside this area the table will topple over.

You can try a simple experiment yourself. Stand close to a wall with one foot and one arm in contact with it. Try to bring the other foot in contact with the one in contact with the wall, without seeking any support. You will find that this cannot be done. This is because our centre of mass is close to the navel and if both feet are in contact with the wall, the vertical line drawn through our centre of mass will be outside the support base and the body will become unstable. When we stand in the normal posture, the vertical line through our centre of mass lies between our feet, and our body is stable (Fig. 8).

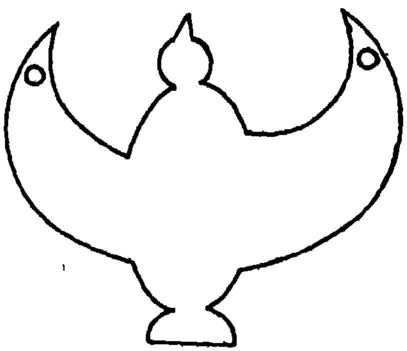

Fig. 6a

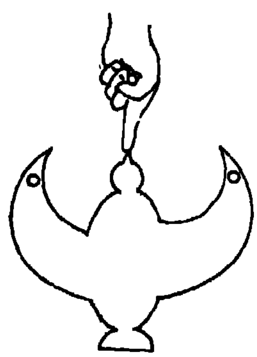

Fig. 6b

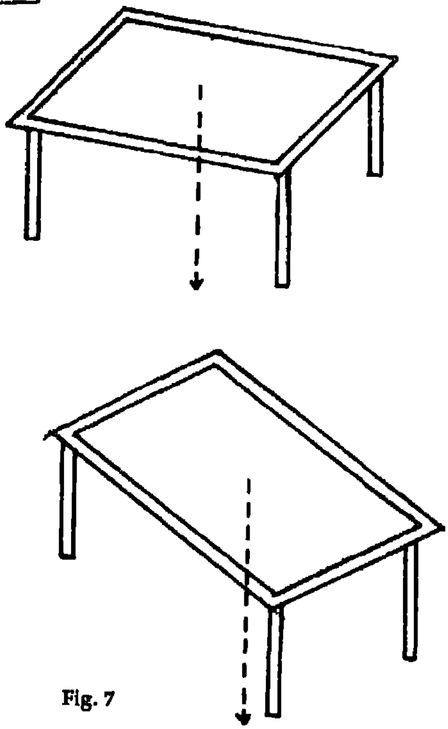

Fig. 7

If you have climbed a hill or a steep slope, you will have observed that one has to bend forward. This is again to ensure that the vertical line through the centre of mass passes through the support base.

Our Atmosphere

As you know, our atmosphere consists of mainly three gases—nitrogen, oxygen and carbon-di-oxide(also water vapour). Table 3 gives more details of the constituents. Life on earth has evolved only because of the relatively large abundance of oxygen. If we examine the composition of the Universe, we find that hydrogen and helium dominate over all other elements. Then how is it that our atmosphere has so little hydrogen and helium?

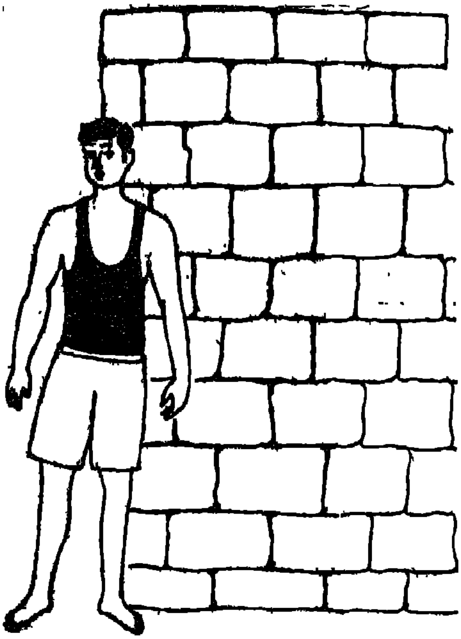

Fig. 8

TABLE-3

Gas	*Percentage*	*Molecular Weight*	*Average (rms) speed at room temperature*
N_2	78	28	0.52 km/s
O_2	21	32	0.48
C_2O	0.03	40	0.432
Nobel gases	0.9	-	-
H_2	Trace	2	1.93

Let us assume that our entire atmosphere is at a uniform temperature of say 27°C (300 kelvin). The average energy of nitrogen molecules will be the same as that of molecules of other gases, e.g., O_2 or H_2 ,...This is technically referred to as the *law of equipartition of energy*. However, this does not mean that the average speed of N_2 molecules will be the same as that of H_2 molecules. We

know that the kinetic energy E of a body is related to its speed by the relation

$$E = \frac{1}{2} mv^2 \qquad ....(8)$$

where m is the mass of the object. For different gases at room temperature the average speeds of molecules are given in Table 3.

We note that the average speed of hydrogen molecules is nearly 2 km/s. In a gas one will find molecules with all possible speeds ranging from almost zero to extremely large values, may be hundreds of km/s. If the average speed is around 2 km/s the fraction of molecules having speeds exceeding the escape velocity (11.2 km/s) will be substantial. Hence there will be fair change of their escaping from the earth's hold. On the other hand if we consider oxygen molecules, their average speed is around 9.5 km/s. Thus the fraction of molecules with speeds exceeding the escape velocity will be small. This partly accounts for the present composition of our atmosphere.

We saw that on the surface of the moon, the escape velocity is only about 2.5km/s. Because of this all gases have escaped from its surface, and there is no air on the moon. Hence no life can exist there. Even two astronauts will have to communicate with each other through radiowaves — there is nothing like sound there.

Gravity in Action

Many phenomena which we observe on our earth are a direct consequence of gravity, though in some cases the connection may not be obvious. Air pressure, water pressure inside oceans, tides, water falls are a few examples. Let us examine them in some detail.

Air Pressure : Inside a quiet room we hardly feel the air around us. But the pressure it exerts on our body is equivalent to a water column of 10 m height. How is it that we are not crushed under so much pressure? This is because, there is the same air inside our bodies and the two forces from inside and outside just balance. An easy way to demonstrate this pressure is the following: Take a tumbler and fill it with water upto the brim. Slip a card over the mouth of the tumbler so that it is fully covered. Hold the tumbler in your right hand and place the palm of the left hand over the card. Quickly turn the whole thing upside down. Remove your left hand from under the card.

The card should stick to the tumbler and not fall off. This is because the force exerted on the card by the air from below is much greater than that exerted from above by water inside the tumbler.

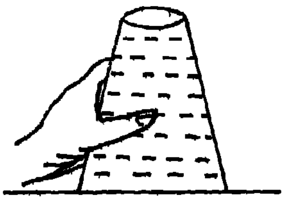

Fig. 9

Tides : The gravitational attraction of the moon causes tides in the oceans. High tides occur both in the part of the ocean directly towards the moon as well as in the ocean directly opposite. If the sun happens to be close to the direction of the moon, then the tides are very high.

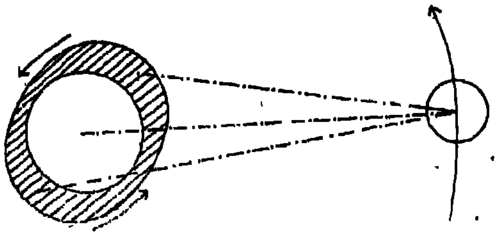

Fig. 10

Water Falls : You may have seen some water falls. They are usually a very grand sight. Some are seasonal and some perenial. When there is a sudden change in the level of the ground along which a river flows, water falls develop. Water falls from a higher level to the lower level because of gravity. In Europe many small water falls were utilized to drive flour mills. Large water falls can be used to generate electricity.

Dams : These days we use lot of energy in the form of electricity. Major electric power in our country is produced in power stations burning coal. Coal stocks are limited and hence lot of attention is being given to nuclear energy and renewable energy sources like solar energy and hydro-electricity. To generate hydro-electricity, a high dam is built across a river when it is flowing among mountains or raised ground. You must have heard of Bhakra and Nangal dams in Punjab and Nagarjuna Sagar dam in Karnataka. Water is allowed to fall from near the top of the dam, to lower levels. This falling water acquires lot of kinetic energy due to gravity, which can be used to run electric generators.

Pendulum : Man has learnt to make use of gravity in various ways. Galileo, while sitting in a Cathedral observed that the period of oscillation of a chandelier hanging from the roof, did not depend upon the amplitude of oscillation. This was a very important discovery, and led to the concept of present day pendulum. It is very easy to set up and study a pendulum. It is just small mass attached to a string, which is tied at the other hand to a rigid support. The mass must be free to oscillate. The time-period of a pendulum is defined as the time required to complete one oscillation say from O to A to B and back to O (Fig. 11).

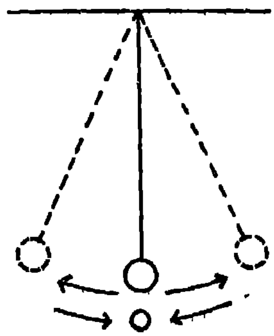

Fig. 11

The time period is dependent on the length of the pendulum and not on the amplitude of oscillation. At one time, pendulum clocks were very common in homes. They have now been replaced by battery driven electric clocks. We have considered here a few examples where gravity is seen to operate. As a matter of fact, life in the universe exists because of this or more generally the sun and the stars and the planets are there because of this universal property of all matter.

Appraising Student Achievement in Mathematics

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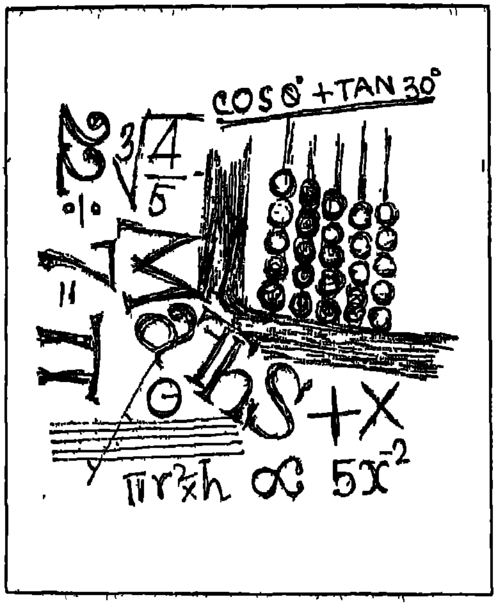

In an era of accountability for teachers, it is vital that quality procedures in evaluation of learner progress in the mathematics curriculum be in evidence. Which techniques of appraisal then need to be emphasized?

Using Checklists and Rating Scales

A checklist may be utilized if progress can be recorded on an either/or basis. For example, a student who correctly finds the area of a square, rectangle, or triangle can receive a checkmark on his/her checklist to indicate that the following objective has been attained : Given the dimensions of each side of a square, rectangle, or triangle, the pupil can compute the area correctly.

The name of the involved pupil needs to appear on the checklist. The date for achieving the objective needs to be recorded next to the objective on the checklist. Relevant sequential objectives only, should appear on the checklist.

The rating scale should be used when general objectives are utilized in ongoing units. It is difficult to state selected objectives in measurable terms. And yet, the following are indeed worthwhile in any unit of study in mathematics : being able to think critically, creatively, and solve problems. Thus, a student's proficiency in each of these higher cognitive level skills may be evaluated on a five point scale, such as doing excellent, very good, average, below average, and poor in thinking critically, creatively, and being able to solve problems.

No doubt, the checklist and its use appraises students objectively, independent of evaluator, whereas the rating scale stresses subjectivity, in degrees. Interscorer reliability in utilising the rating scale can be emphasized by having a colleague assist in developing the ratings on a five point scale. If the two raters of student achievement in critical thinking, creative thinking, and problem solving agree, the chances are reliability with its

consistency of results is in evidence.

Using Standardised Tests

In using standardised tests to appraise student progress, teachers of mathematics in a school system need to notice validity correlation coefficients, as well as reliability values. Certainly, the test used to measure pupil achievement must appraise student progress in terms of what it purports to measure and in this situation achievement in mathematics. Validity in the measurement instrument is then inherent. Consistency of results is also wanted if a test, for example, were taken over again by the student. Otherwise, what worth would a test have if the same pupil taking it two times would rank on the 70th and 25th percentile respectively? Inconsistent results are then in evidence. Ranking on the 70th percentile is high since out of every 100 taking the test, thirty would be above and seventy below. Being on the 25th percentile is low. Thus, out of every 100 students taking the test, seventy-five would be above and twenty-five below for the person taking the test and ranking on the 25th percentile.

Standardised achievement tests are norm referenced. When viewing the results from standardized achievement tests in mathematics, pupils scores are spread out from high to low. This is typical of norms referenced testing. Thus, a student's results can be compared with others in a classroom or schools. The range in percentile ranks could be from 99th to the first percentile. Or, if grade equivalents are given for each student, the range could be from twelve to grade three, as examples, for a class VII student.

Norm referenced tests have been standardised on a set of students which should possess similar traits and characteristics, as the general population in society. Otherwise, the concept of external validity would be lacking. For example, if one's present classroom of students were all gifted by definition and the norm group on which the achievement test was standardised were heterogenous (mixed achievement levels). It would mean that the two sets would be highly incongruous. Results of the gifted students can be compared to the norm group. However, the chances are that the standardised test will not measure as accurately as one would wish the results to be for the gifted students. Why? There would be relatively few students in the norm group who were gifted, compared to average achievers. In the norm group, most students will have measured close to the mean or arithmetical average. One standard deviation (34 per cent of the norm group) below the mean and one standard deviation above the mean (another 34 per cent of the norm group) make for 68 per cent the students in the norm group. These students represent a range of percentiles from the 16th percentile to the 84th percentile. Thus, most of the students in the norm group have been taken into consideration with the $\pm$ one standard deviation above the mean. Gifted students in our classroom would tend to score above or well above the 84th percentile. Just 16 per cent of the students in the norm group scored higher than one standard deviation above the mean. Add another standard deviation above the 84th percentile (one standard deviation above the mean is the 84th percentile approximately) and a student is on the

98th percentile. Thus, two standard deviations above the mean and two standard deviations below the mean account for 96 per cent of the norm group, leaving two per cent three standard deviations above the mean and two per cent three standard deviations below the mean. Thus, one's own gifted class of students in comparison with the gifted on the norm group would find few in number of the later. Most students in the norm group would cluster more so toward the mean. Thus, an inadequate number of students three standard deviations above the mean are available to compare results with the teacher's own gifted class. Better comparisons can be made with average and talented students in the norm group if students in the teachers' classroom are also of similar abilities. An adequate number of any category of pupils be they high, average, or slow learners need to be in any norm group so that students in classrooms who come in any one of these categories may have adequate numbers for making comparisons.

Criterion Referenced Tests

Norm referenced test results provide for a range of achievement among students. Thus a spread of scores are involved from high to low. On the other hand, Criterion Referenced Tests (CRTs) may not provide for much of a spread of scores among students. CRT philosophy is much different than norm referenced generalisations. In CRTs, whether teachers, school, or commercially developed, measurably stated objectives are emphasized. The objectives exist prior to instructions of pupils. Either students attain or do not attain the chosen ends. No guesswork is involved in these testing situations.

The teacher can announce to students at the beginning of a class session which objective(s) a student is to attain. The mathematics teacher may then teach to the stated objective. The learning activity or activities are valid in that they harmonize directly with the objective. Finally, the instructor appraises to see if each student has or has not achieved the specific objective. The teacher then stresses a similar sequence, announce the measurable objective to learners prior to instruction, teach so that students are on course to directly attain the precise end, and measure to notice which pupils have been successful in goal attainment. If a student did not achieve a measurable objective, additional learning activities need to be provided so that the involved learner can be successful in attaining the chosen end(s).

Time is the variable in CRT. Thus, slow learners will need more time as compared to average and gifted students to achieve worthwhile objectives. A computer printout of sequential objectives may be sent home with the pupil to parents. Along with each objective on the printout are the textbook, workbook, and/or worksheet pages so that the parent might know exactly which learning activities assist students to attain an end. On the elementary school level, in most cases , it is possible in homework for parents to help their offspring achieve objectives.

Thus, slow, average, and fast learners can achieve the same sequential objectives. More time and assistance must be given to the slower achiever to attain sequential ends.

From CRT results, there might well be a spread of scores in achievement from high to low. However, that is not the point. The goal in CRT is to assist each student to achieve as many specific objectives as is reasonably possible. Absolute standards are then emphasized. Either a student has or has not achieved a sequential objective.

Anecdotal Records

Teachers of mathematics need to take time to record representative behaviour of each student. Unless behaviours are recorded, they can be forgotten by the teacher. Representative behaviour of each student needs to be recorded. Biased statements written for any pupil should be omitted. Loaded words also should be left out of written anecdotal statements. If a teacher records observed behavior for two students each school day, it does not take long before the rounds have been made one time. For example, with 24 students in a classroom, it should take the teacher twelve school days to complete writing the anecdotal statements for involved learners. The teacher needs to continue writing the anecdotal statements throughout the school year to notice patterns of behaviour for each student.

Which statement(s) might be written as an example for a student?

> September 7, Lois completed her assignments with no errors in the completed work.

This anecdotal statement is factual and verifiable. No loaded terms were used. The statement indicated the kind of behaviour exhibited by Lois.

Another example of an anecdotal statement would be the following:

> September 8, Albert looked around the room for five minutes before starting on his mathematics assignment. He missed 15 out of the 30 addition computations.

Again, a factual statement of Albert's achievement has been recorded. Other observers should be able to verify or refute Albert's observed behaviour.

Student Products

Homework and schoolwork assignments provide an adequate supply of student products in terms of completed work. Pupils with teacher guidance may diagnose and remediate errors made by the former. From learner products in mathematics, the teacher may notice the kinds of mistakes students make in ongoing units. The errors may be due to :

1. Human factors in that perfection does not reside within the individual.
2. Carelessness on the part of the student.
3. Computational errors.
4. Not understanding an operation or process in mathematics.
5. A lack of readiness within the pupil.
6. Not perceiving purpose or reasons for learning.
7. Poor sequence in instruction.
8. Not perceiving interest in learning.

By diagnosing student progress in mathematics, the teacher can make appropriate judgments in terms of which objective should come next in sequence. Feedback from student products provides teachers with needed information on which learning activities in mathematics need to be provided to learners. Success in learning is basic for students to achieve optimally in the mathematics curriculum.

Teacher Written Tests

Periodically, the teacher will wish to appraise student progress through testing. Test results from learners can provide excellent information to the teacher as to which goals need to be emphasized within diverse units of study.

One kind of teacher written test item appropriate for measuring mathematics achievement is the multiple choice item. The following is an example :

The formula for finding the area of a circle is

(a) $r2\pi$ (b) ½bh (c) 1w (d) s^2

Criteria to emphasis in writing multiple choice items include the following :

1. Content needs to be clearly written so that either a, b, c, or d is the correct response. Sometimes more than a single response is correct in a multiple choice item. In the directions for taking the test, clarity is important in the printed content. Students should know precisely how to take the test as a result of having read the directions.
2. The distractors should be plausable. Too frequently, teachers have written ridiculous distractors whereby students need minimal knowledge to eliminate the bizarre, such as

   The formula for finding the area of a circle is

   (a) 13 + 7.
3. No clues should be given as to which response is correct or incorrect. The following violates this standard :

   The Pythagorean theory in finding the diagonal of a right triangle was developed by

   (a) Pythagoras (b) Plato
   (c) Aristotle
4. Unnecessary words should be eliminated in any test item. The following is an example of useless wording :

   The formula $r^2\pi$ is used

   (a) to determine the area of a square.
   (b) to determine the area of a circle.
   (c) to determine the area of a triangle.
   (d) to determine the area of a rectangle.

   To eliminate excess words, the multiple choice item should be rewritten in the following way :

   The formula $r^2\pi$ is used to determine the area of a

   (a) Square (b) circle (c) triangle
   (d) rectangle.
5. The determiners "a" and "an" need to be carefully used in written multiple choice items. For example, in the following test item the article 'an' provides the clue as to which is the correct answer:

   The formula "a=1w" is not applicable in finding the area of an

   (a) square (b) rectangle (c) ellipse

   The only correct answer would be *an* ellipse.

True-false items can be used to evaluate pupil achievement in mathematics, such as in the following clearly written test item :

The formula for finding the circumference of a circle is $d\pi$.

The answer to the above true-false item is clearly true. If a true-false item is false, the student could be asked to correct the part that is false. For example, supposing the following item is on the test :

The formula for finding the area of a square is bh÷2. The underlined part is false may then be corrected by students so that it reads s^2.

A matching test can be developed

by the teacher to measure factual learnings acquired by students. It is significant to follow the following criteria when developing matching tests :

1. Have more items in one column compared to the second column to match. Thus, the process of elimination cannot be used extensively to complete the matching test.
2. Have phrases or single concepts in one column to match with the second column. Column two may also contain phrases or single concepts. However, if both columns contain lengthy sentences, the matching test may be complex indeed. One column may have sentences of reasonable length.
3. Develop a test of moderate length so that fatigue does not set in on the part of the student taking the test. The mathematics teacher is attempting to measure conceptual learning and not necessarily endurance in taking the matching test.
4. Use a single topic when developing test items. If items pertain to diverse topics, it may be relatively easy for a pupil to match selected items in column A with column B. Thus, a matching test may deal with the topic of formulas to determine areas of diverse geometrical figures. A single topic is then utilized in developing the matching test. If a simple addition problem were added to the test involving the above named formulas, it would be relatively easy for the learner to notice that only one possible matching could be made in relating column A with column B of the test items, e.g. a numeral plus a numeral equals a numeral.

Short answer or completion items may be utilized in testing. The following is an example of a short answer test item :

> A+B=B+A emphasises the _________ property of addition. There are relevant criteria to follow in writing short answer test items .

1. Adequate information must be provided in the short answer test item so that students know what is wanted in terms of responses. The following short answer item lacks needed subject matter in terms of responses wanted :

   _____and_____are the ______ of______
2. The blanks in short answer test items should be of equal length so that clues are not given to the test taker as to which the correct answer is.
3. The blank spaces should be numbered sequentially to make for ease of scoring.
4. It is important to write subject matter clearly so that the involved test taker interprets the short answer test items accurately.
5. Learners need to have an adequately developed writing vocabulary to respond correctly to the blanks in short answer test items.
6. The teacher needs to give credit to correct responses even though they differ from the right answer written on the teachers' own originally developed key.

Essay items as a fifth type of teacher written test item may be utilised to apprise student progress. Thus, an essay item might be written to have students clarify and explain thinking involved in solving a word problem. The following is an example.

> Mr and Mrs Brown and their two children, aged seven and ten, took a vacation trip in which 1,500 km were travelled. The car averaged ten km for each litre of gasoline used on the excursion. The price of the gasoline was

@ 26 per litre. The total cost for lodging was $280 for the vacation trip which lasted seven days. The average cost per day for meals for each of four family members was $12. How much did the total vacation trip cost? In your answer, give reasons for using each numeral and/or number name used.

Here students need to analyze their thinking in terms of how each numeral and number name is to be utilized. In the analyzation, selected values will not be used in solving the problem. The cognitive level of analysis may then be appraised by the teacher.

The mathematics teacher may also appraise if pupils can apply that which had been learned previously. Thus, are students able to utilize the cognitive level of application within the framework of problem solving? If a pupil cannot use what has been acquired previously, perhaps meaning and purpose were omitted on the learner's part in learning experiences prior to the essay test item that needs its required responses.

In any essay response, the teacher can notice the quality of spelling, handwriting, punctuation, usage, capitalization, and sequence of ideas. The mechanics of writing described above, should be appraised separately from content or subject matter needed to solve the problem.

In writing essay tests to appraise student progress in mathematics, the teacher must

1. Write adequately delimited test items. The following essay item is too broad: Discuss mathematics.

Volumes have been written and will continue to be written on mathematics.

The following essay item is adequately delimited :

Describe the meaning of each symbol in the formula A= ½bh.

2. Write essay items which are not too factual in terms of needed student responses, such as :

"What is the formula for finding the area of a parallelogram?"

A quality true-false, multiple choice, matching, or completion (short answer) test items can deal in a more effective way with factual content, as compared with the essay test. Thus, instead of the essay item

"What is the formula for finding the area of a parallelogram?"

The following completion item would suffice:

"The formula for finding the area of parallelogram is_____________.

Conferences with Students

The mathematics teacher can assist student achievement with the use of conferences. The teacher may meet with one or more (a small group) students to discuss common errors made in ongoing learning activities. Diagnosis is an important concept to emphasise in the conference setting. Which specific errors did one or more learners make? The following are examples of common mistakes:

1. Not copying a problem correctly from a textbook or workbook.
2. A lack of understanding of the terms carrying and borrowing. Another name for the same kinds of errors would be regrouping and renaming.
3. Inability to recall answers to basic addition, subtraction, multiplication, and

division number pairs.

4. Not being able to apply formulas in mathematics to concrete situations in life.
5. A lack of proficiency in reading content, such as story problems in mathematics. If a student cannot identify, approximately, ninety per cent of the words in word problems, comprehension will tend to go downhill.
6. Inability to analyze in items of needed content as compared to the unneeded in solving word problems.
7. Lacking the desire to evaluate personal achievement in ongoing lessons and units in mathematics.

Thus, the conference method in an atmosphere of respect can assist individual students to achieve at a more optional rate of progress.

Parent-Teacher Conferences

An adequate number of parent-teacher (PT) conferences should be held in any given school year. Mathematics teachers need to inform parents of their son or daughter's progress in a face to face situation. Too frequently, report cards alone are utilized to report pupil progress to parents. However, report card results are a one way street of communication. Parents, no doubt, have questions pertaining to items on a report card. Sometimes PT conferences are held right after the report card has been issued the first time to a pupil in a given school year.

To achieve readiness in having a PT conference, the teacher needs to ;

1. Have work samples pertaining to completed daily assignments of the involved student. The parents need to see the quality of work done by their offspring. Seeing directly products of a student is better than merely attempting to describe how well a pupil is achieving in mathematics.
2. Be knowledgeable about the capacity and general achievement level of the student in the area of mathematics.
3. Understand attitudes possessed by the learner toward mathematics.

In a PT conference, the teacher must:

1. Accept parents as human beings having a sincere desire in wanting their son or daughter to achieve well in the mathematics curriculum.
2. Respect the thinking of parents. Nothing is gained by exhibiting feelings of hostility and mistrust.
3. Work together with the involved parents in guiding each pupil to achieve optimally in mathematics.

Certainly, PT conferences are vital in improving the mathematics curriculum!

Oral Tests

For blind or partially sighted students, oral tests may be utilised to appraise progress. The normal learner, in selected instances, may also benefit from oral testing. The use of oral tests can eliminate the reading factor in measuring student achievement. Sometimes, a mathematics test appraises reading skills, such as in word or story problems. However, teachers should attempt to ascertain students' progress in computation, concepts, and problem solving. Oral tests can be valid and reliable to measure achievement in mathematics.

Content validity is involved in selected oral items to utilise in appraising student progress in mathematics. Each item selected should relate directly to

the precise, measurable objective emphasized in teaching and learning. Thus, the effectiveness of the teacher's proficiency in the teaching of mathematics is being appraised: Did the involved student attain the precise ends? It is an either or situation. Either the pupil was or was not successful in goal attainment. If a learner has not been successful in achieving an objective, diagnosis of the situation is necessary to determine causes and remediation methods.

Test items, orally administered, that relate directly to the statement of precise objective should be valid. Thus, learning activities have been provided by the teacher which guided students to achieve the specific ends. After instruction the teacher measured the involved pupil's achievement to notice if the stated objectives had been attained. In situations such as these, the test is valid, if items are clearly stated orally, since the learning experiences guided students to achieve the precise objectives, and the measurement procedures harmonized directly with the statement of objects.

Consistency of results from students who have been administered an oral test in mathematics is important. One way of ascertaining internal consistency in administering a test is to compare odd versus even numbered items. Did those learners who scored high on the even numbered items also score high on the odd numbered items? The teacher may wish to rank each pupil in the class from high to low in the even numbered items on the oral test. The same also needs to be done for the odd numbered items. A reliability coefficient can then be computed for internal consistency. In any teacher determined test be it oral or written, internal consistency reliability can be computed when comparing students in class with responses correct to even versus odd numbered items.

Sociometric Devices

Periodically, the mathematics teacher will wish to have pupils work cooperatively within committees. To determine committee membership, the teacher may want to utilize the sociometric device. Sociometric devices attempt to evaluate social, not academic growth.

The teacher may have students list on paper their first, second, and third choices in working on a committee. Learners need to be assured that their responses will be kept strictly confidential. Also, the mathematics teacher needs to mention to students that the results of the sociometric device will be utilised to determine committee membership.

What might the teacher appraise from the responses given by students as to whom they would prefer to work with on a committee?

1. Students that are chosen frequently by others.
2. Learners who are on the fringe area in that they are chosen, perhaps, only once and that being a third choice.
3. Individuals who are complete isolates.

Guidance can be provided by the mathematics teacher in assisting isolates to becoming increasingly accepted by others. Changes here generally will take place slowly. Students who are isolates can be placed in committees in which other learners are highly accepting of others. Certainly an isolate should not be placed in a committee or small group of cliques.

The goal for any committee to attain is to achieve as much or more using this method of teaching as compared to other procedures.

In Closing

There are numerous means available to ascertain learner progress in the mathematics curriculum.

These include using :

1. Checklists and rating scales
2. Standardised tests
3. Criterion referenced test
4. Anecdotal records
5. Student products
6. Teacher written tests
7. Conferences with students
8. Parent-teacher conferences
9. Oral tests
10. Sociometric devices

Each evaluation technique has its strengths with selected limitations also. The mathematics teacher needs to utilize a variety of procedures to appraise student progress. With quality evaluation results from students, the teacher may truly develop a sequential mathematics curriculum from which all students might benefit optimally.

The World Moves on Internal Combustion Engines

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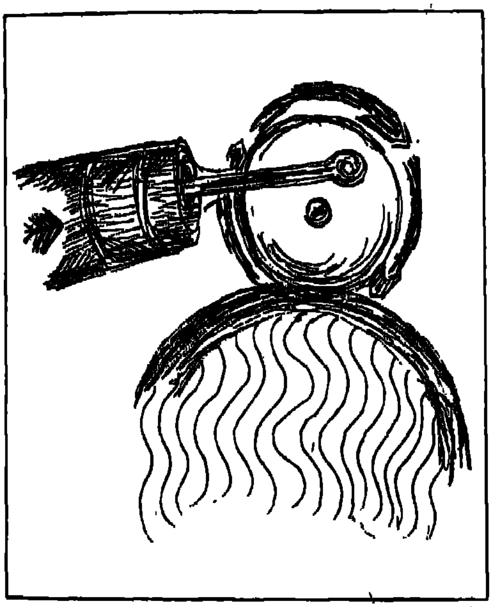

The twentieth century has witnessed a great revolution in transportation, thanks to the internal combustion (I.C) engine. Passenger cars, buses, trucks, modern locomotives and aeroplanes are powered by I.C. engine. Before its advent, people depended mainly on animal-drawn carriages for short-distance movement and on steam-powered trains and ships for longer distances.

In the present day world, I.C. engines play a dominant role in transportation. The passenger car, by providing fast personal transportation, has conferred great freedom of movement on individuals. It is no wonder that hundreds of millions of automobiles are in use in the world and for most of the people who don't have a car, it is a great ambition to own one. Buses and trucks, powered by I.C. engines, can move people and goods to areas inaccessible to railways. Modern ships are also mostly powered by large I.C. engines, rather than by steam.

Apart from the transportation sector, the I.C. engine also plays a big role in agriculture, construction, power generation and in the armed forces. Tractors and combined harvesters are driven by I.C. engines. Bulldozers, dumpers, road rollers and mobile cranes, so important in building construction and road laying, function on I.C. engines.

Modern armed forces are heavily dependent on the I.C. engine for their effectiveness. In the army, tanks, self propelled guns, armoured personnel carriers (APC) and trucks for moving soldiers and supplies—all are powered by I.C. engines. The planes of the Air Force and the ships of the Navy too have I.C. engines as the motive power.

In short, a large part of the economic activity, military operations and movement of people in the modern world would come to a grinding halt in the absence of the I.C. engine.

The bulk of the I.C. engines in use fall into two categories; the Spark Ignition (S.I.) engine (also called petrol engines)

and Compression Ignition (C.I.) engines (also called Diesel Engines). Most of the modern aircrafts use another variety of the I.C. engine called the gas turbine (jet engine). There is a long and interesting story behind the development of these engines.

Though several versions of the internal combustion engine were conceived and built by Christian Huygens, Lenoir and others, the modern I.C. engine took shape at the hands of two inventors, Nikolaus Otto and Rudolf Diesel, both of Germany. In 1876, the petrol engine, developed by Otto, came into use. The diesel engine developed by Dr. Diesel, came into use in 1896. The use of I.C. engines in automobiles was pioneered by Gottlieb Daimler and Karl Benz of Germany. But large scale use of automobiles was made possible by Henry Ford of the U.S.A. through the mass production techniques that he pioneered. He built and sold an incredible 15 million cars in less than two decades!

The gas turbine came into use later than the reciprocating I.C. engine since it faced greater technical problems. It was developed in the 1920's and 1930's by Sir Frank Whittle in the U.K. and Ernst von Ohain in Germany in the face of great technical problems and against official apathy and opposition. Jet fighter planes came into use shortly after the Second World War and passenger jets were produced in the late 1950's.

Twentieth century developments like the automobile and the aeroplane, though dreamed of for a long time by inventors, became possible only after the I.C. engine was developed. Steam engines, for example, could never have succeeded in their place.

The basic working principle of the I.C. engine is quite simple, though the practical engine is complicated due to refinements. Fig. 1 shows the working principle of the 4-stroke diesel engine schematically. During the first stroke of the piston (downwards), the suction stroke, air is drawn into the cylinder through the open inlet valve. During the second stroke, the compression stroke, both the valves are closed and the air is compressed. Then fuel is injected under high pressure into the cylinder. The fuel gets ignited by the high pres-

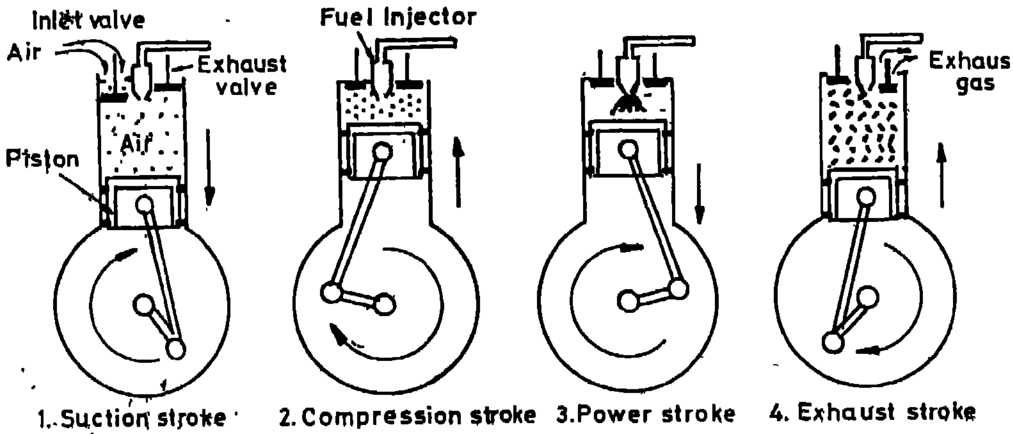

Fig. 1 *Working principle of the four-stroke diesel engine*

sure and temperature. This raises the pressure of the gas in the cylinder. The piston is now driven down in the third stroke, the power stroke. Work is done by the piston only during this stroke. The other three strokes are carried out through the kinetic energy stored in a flywheel. During the final stroke, the exhaust stroke, the products of combustion are pushed out through the open exhaust valve by the piston moving up. This cycle is repeated as long as the engine runs.

The movement of the piston is converted into a rotary motion by the crankshaft of the engine. This shaft then drives the wheel of a truck or bus (through a gear box and differential) or other machinery like a pump directly connected to it.

In the 4-stroke petrol engine, during the suction stroke, a mixture of air and fuel is drawn from a carburetor into the cylinder. At the end of the compression stroke, the mixture is ignited by an electric spark and burns. The other functions are the same as in the 4-stroke diesel engine.

Fig.2 shows the 2-stroke petrol engine

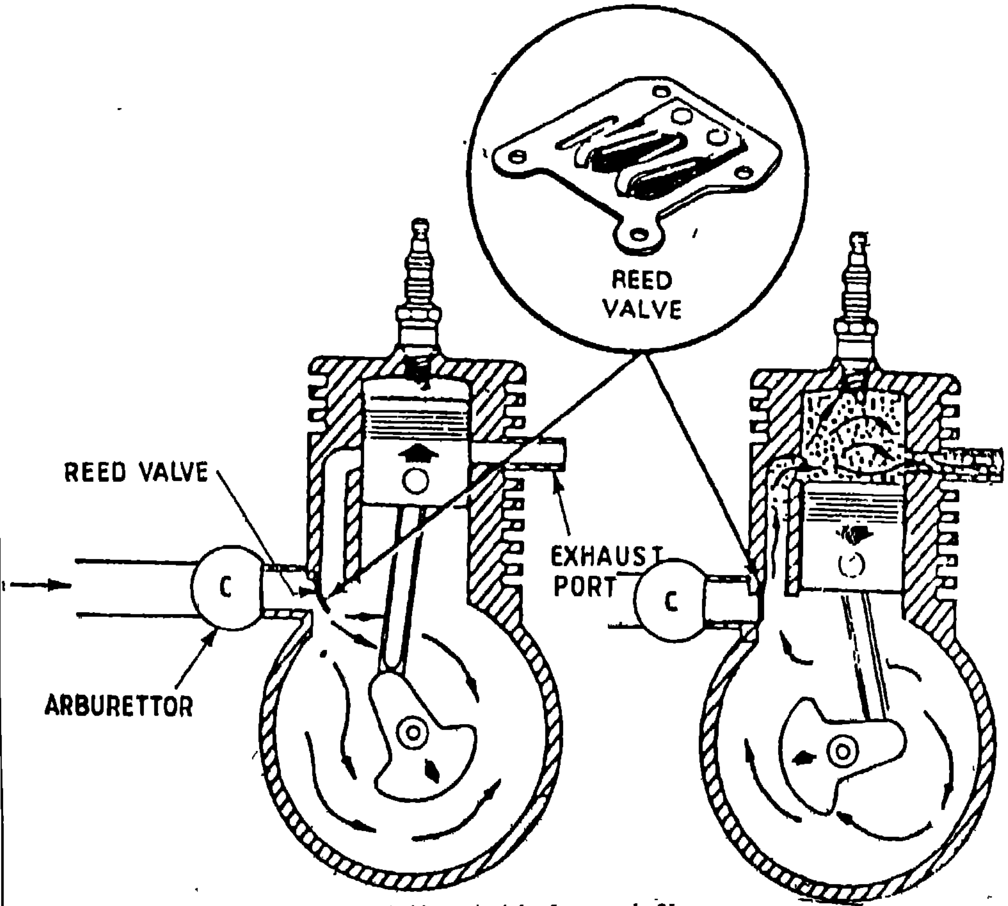

Fig. 2 *Working principle of two-stroke SI engine*

schematically. In this type of engine, the cycle of operations is completed in 2 strokes of the piston, corresponding to one revolution of the crankshaft. During the upward movement of the piston, the compression stroke, air-fuel mixture is being drawn into the crankcase from the carburetor through a reed valve (which allows the mixture to come in, but not to go out). At the end of the compression stroke, a spark ignites the mixture and the piston moves down on the power stroke. It first uncovers the exhaust port (see figure) and a little later the inlet port. The downward movement of the piston makes the fresh mixture flow into the cylinder and push out the products of combustion. Thus the expansion, suction and exhaust functions are combined in one single downward stroke of the piston. The cycle of operations is completed in 2-piston strokes, that is one revolution of the crankshaft.

Two-stroke petrol engines are lighter, cheaper and simpler than 4-stroke petrol engines and hence they are widely used to power 2-wheelers like scooters, motor cycles, mopeds etc. But they consume more fuel and are more polluting than 4-stroke petrol engines.

Aircrafts are powered by a different kind of I.C. engine, the gas turbine (the jet engine). Fig.3 shows this engine schematically. Air is sucked into the turbine, which compresses it. Fuel is injected into this compressed air in the combustion chamber. The hot gases from this chamber pass through the turbine, driving it. The turbine is mechanically coupled to the compressor, supplying it the power necessary for compression. The exhaust gases from the turbine pass at high speed through a nozzle into the atmosphere. The reaction to this gas flow propels the aircraft forward, in accordance with Newton's Third

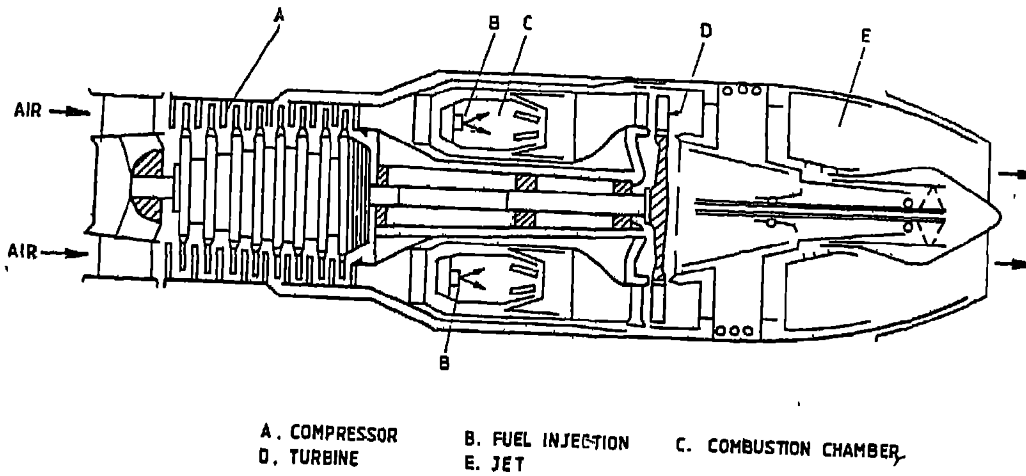

Fig. 3 *Schematic view of a turbo-jet engine*

Law of motion. The gas turbine is more powerful, smoother and lighter than the reciprocating (piston) engines described previously. Hence for jet aircraft, where light weight is important, gas turbines are used, even though they are less efficient than 4-stroke reciprocating engines. Today there are huge aircraft like the Boeing 747 (Jumbo Jet) powered by gas turbines, which can carry upto 400 passengers.

When they operate, I.C. engines emit into the atmosphere pollutants like CO_2, unburnt fuel and Oxides of nitrogen (NOx). Hence a tremendous amount of research work is going into controlling such pollution through better engine design and exhaust catalytic converters.

In spite of its drawbacks the I.C. engine is so useful to society that it is likely to be in use for several more decades. Many alternative power plants like fuel cells, batteries etc. are being looked into but they are likely to take its place in the near future. The sturdy and reliable I.C. engine will continue to serve us long. While enjoying its service let us not forget the long years of labour that indomitable pioneers like Nikolaus Otto, Rudolf Diesel and others put in to develop it for mankind.

Why Animal Dissection in the School?

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If there is one area of our interest where Newton's third law of motion does not quite apply, it is most certainly to education. For every educational advance, there is an opposite but unequal and vehement reaction. This is almost a global phenomenon. In the US, for example, if one attempts to teach evolution, one is harassed by anti-evolutionists. Over a hundred years after Wilberforce and Huxley exhausted all their arguments, there are pockets of anti-evolution sentiment. While teaching the biology of sex, one is attacked by anti-sex educationists, despite climbing rates of AIDS. There are those who wish to prohibit schools from discussing matters that pertain to sex.

One of the more recent trends is resentment of the use of organisms in the laboratory. In some states in the US there are laws that prohibit the use of animals in the classroom for any purpose whatsoever.

As well as in the US, some people in India are asking for restrictive legislation on this not because they care to understand the processes of education or the purposes these processes are expected to serve. Such groups are headed by vocal minorities wielding political pressures. Tenable and untenable arguments are hurled at each other by pro- and anti-dissectionists. Some of these arguments — from both sides — are either trivial or at best trite; no comments on those are called for. What is necessary is an objective analysis of the school biology curriculum, the desired outcome in terms of learning experience, practices in schools insofar as dissection of animals is concerned and examination of possible alternatives to dissection that can be adopted for our schools.

The value of dissection can only be judged in the fuller context of experience, feeling and morality.

The Case against Dissection

Many of the criticisms levelled at the use of laboratory animals are not criti-

cisms of facts but rather of opinions. Often they are a hodgepodge of desperate views. We can try to bring some kind of coherence in them thus :

The act of dissection brutalizes pupils. What they do to organisms in a dissection class is a reflection of the way they will treat fellow humans.

Dissection is a tradition-bound activity that survives on the ground that it has always been a part of the syllabus.

A large number of students are numbed by revulsion at the dissection table. In such cases, children should have the option of learning anatomy and morphology with the help of charts, models, computer simulations and other available aids.

Many of these students give up biology as an elective subject at the Senior Secondary stage driven by their traumatic experience of dissecting animals.

A huge number of amphibians and rodents are destroyed every year in Indian schools as children dissect these animals. This disturbs the ecological balance and threatens some animals with extinction.

In many countries, noteably in the UK and the USA, many schools have done away with dissection.

The practice of dissection, therefore, should be abolished from school biology.

Emotions often run high while people debate on these. We shall look at them only dispassionately.

First, the contention or inference that what people do to organisms during dissection is a reflection of the way they will treat their fellow humans is based on wild assumptions.

Secondly, there is no single curricular activity that makes all pupils happy or unhappy. Emotional disturbance may arise as a result of shock on the sight of dissected animals. Such disturbance may also arise from the use of film showing exposed heart or blood. In my ten years as a biology teacher, I didn't come across a single student who gave up biology due to emotional disturbance. I know many a student who feel excited about the dissection class and make it a point that they don't miss it. Most students feel like surgeons when operating on anaesthetized rats.

Thirdly, these who choose biology as an elective subject at the Senior Secondary stage (and dissection is a prescribed activity only for them, not for any earlier stage of schooling), are no longer children but young adults. They opt for biology willingly with a career prospect in mind. If some of them later find themselves too sensitive to dissection, they can amend their choice of subject. In any case, it is not sufficient to argue the case against dissection on grounds that 'children are Squeamish'.

Fourthly, a strong ecological point is often made against dissection. The species *Rana tigrina* is threatened with extinction allegedly because of its large scale use at the dissection table. Common toads are no better off. The fact of the matter is that amphibians have long been excluded as animals for dissection. If *Rana* becomes extinct before long, it would be because too many people look for its delicate legs at the dinner table. Export of these legs is lucrative business. Rats, which are known pests that are destroyed regularly at a much large scale to prevent loss of food grains, are

the animals that are dissected in the biology classroom. The rate at which rats breed outpace their rate of destruction through dissection in schools. The extent of ecological disturbance caused by dissection of two or three specimens by a student in two years at the Senior Secondary School is far from established. The number of animals that would be saved by abolishing the practice of dissection from the school stage would be insignificant.

Finally, when one is faced with the charge that laboratory experimentation diminishes pupils' kindness towards animals, one has the option of dismissing such a charge as simply a visceral feeling, *for there are no measures of degree of kindness*. Emotional and moral issues continue to be there no matter whether animals are sacrificed at the school level or in the college.

I have heard people saying that if aeroplane pilots and cardiac surgeons can be trained on simulators, why can't students of biology learn anatomy with computer simulations. Strong argument! And whatever its merit, it has been put to practice in some countries albeit at a limited scale. Curriculum developers may try to work out the input required to (i) create what is widely known as virtual reality that makes you feel as though you were dissecting an animal, (ii) produce multi-media packages that simulate dissection, (iii) provide schools with the hardware that handles CD-ROMs and, of course, (iv) procure necessary software.

The Case for Dissection

The argument in favour of dissection usually runs like this :

> The skill of dissection is important for biological investigations at all levels. Information and skills obtained through dissection are a necessary aspect of the training of those who aspire to be biologists, nurses, doctors and the like.
>
> There are people who acknowledge the benefits derived from studies involving dissection. They see beauty and fascination in the bodies of organisms and have a first-hand understanding of the workings of the bodies of living things.
>
> Alternatives to dissection — charts, models, photographs or computer software — can be used to supplement dissection. But examination of the actual object results in better learning than through the use of representative materials.

This train of argument is not devoid of interest points. First, the skill of dissection is thought to be necessary for future biologists, doctors and nurses. That is a strong suggestion that dissection is preparatory to something that would take place some time in future; it has no intrinsic value in the context of school biology *per se*. If so, it is not clear why two or three sessions of dissection that pupils go through must be had in schools and not in the first year in degree colleges or in medical colleges or nursing schools. The rationale for dissection must be found within the framework of the school curriculum; if it is not there, dissection should be abolished from schools.

Secondly, more surgeons than one think that the skill that one acquires in the school dissecting a couple of rats is of little value to a medical student who

has to work on the human body. The experience of dissecting rats helps one dissect more rats, more efficiently in some cases.

Finally, let us accept that although in most schools dissection is done, as it should be, on anaesthetized animals, school laboratories have very poor hygienic conditions. Arrangements in schools for disposal of used animals are pathetic, to say the least.

What Then!

Animal dissection in schools has been dragged into much controversy. The solution lies in an objective response to the singular question, and its natural extension : Is dissection an essential activity for learning biology at the Senior Secondary level? If so, why?

The primary source where we should search for an answer is the biology curriculum which prescribes dissection of rats at the Senior Secondary level.

From Primary classes through the terminal years of schooling, study of the human body — its internal structures and functions of its various organs — is a constant feature of school biology. A substantial portion of the biology course for classes eleven and twelve is description of mammalian anatomy with the example of various systems of man.

The internal anatomy of any mammal, even that of a rat — black or white — it is a useful model that helps understand the human anatomy.

Dissection, like any other practical activity, offers the opportunity to combine cognitive knowledge and psychomotor skills. It reinforces both; one cannot dissect without the knowledge of anatomy and the knowledge of anatomy is grossly incomplete if it is not acquired through dissection. Besides, dissection is as much a means of biological enquiry as it is an exercise to acquire manipulative and investigatory skills. It is the only way to investigate the internal organs and the spatial and physiological relationships between various structures and their functions. Understanding of these is one of the desired outcomes of school biology. This makes a strong case for animal dissection as an essential component of biology curriculum at the Senior Secondary stage.

It is not much of a child who does not dismember toys, dismantle beyond repair household appliances — much to the annoyance of elders — and 'dissects' whatever other object it can lay its hands on. This is instinctive behaviour of the child to explore the unknown. Animal dissection is but a disciplined way to explore the anatomy of animals. Don't stop it.

Introducing Algebra as Pattern Language

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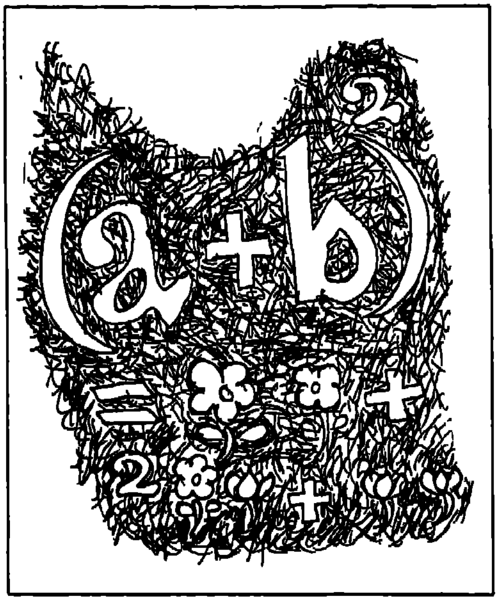

It is being held by many educators (Paige, 1978; Larcombe 1985; Eperson, 1986) that algebra, in fact, develops out of search for patterns, relationships and generalisation. Therefore, it should be introduced as a pattern language without use of symbols although use of alphabets as symbols is the main characteristic of algebra.

The transition from arithmetic to algebra should be carried out through pattern language. The arithmetical patterns should be observed, generalised then verbalised through language first. This may be followed with the algebraic expression. If this sequence is followed, then algebra can be even introduced at the primary stage. In this respect, Costello (1991) says that it is the manner and context in which algebra is introduced matters and its introduction does not depend on any critical point in a child's mathematical development.

Costello suggests the following sequence starting from arithmetic to calculus by pattern language (Fig.1).

Generalised Arithmetic
↓
Pattern Language
↓
Construction of Equations
↓
Interpretation and Solution of Equations
↓
Functions through Graphical Display
↓
Calculus

Fig. 1 *Sequence from arithmetic to calculus*

The NCERT textbook introduces algebra as an isolated concept and not an outgrowth of arithmetic. Algebra is introduced at the grade level six in our schools directly through symbolic expressions. It would be worthwhile if it is done through pattern language instead.

Srinivasan (1992) tried an experiment by presenting algebra as a language of patterns and designs to the primary students. The experiment re-

sulted in significantly positive results. The primary students could grasp the intricacies of algebraic expressions once they became familiar with the pattern language.

Some Examples

Given below are some examples which can be helpful in effecting transition from arithmetic to algebra with the help of pattern language.

EXAMPLE 1

Pattern : 9x9 = 81 8x8 = 64 7x7 = 49
10x9 =90 9x7 = 63 8x6 = 48

Investigations : (a) Do you see any pattern in this series? (b) Does it always happen; try by starting from different numbers?

Pattern Language : When the predecessor and successor of a number are multiplied, the product is always equal to square of the number minus one.

Algebraic expression :

$$a \times a = a^2$$
$$(a + 1) \times (a - 1) = a^2 - 1$$

EXAMPLE 2

Study the following pattern of triangular number

1	=	1
1 + 2	=	3
1 + 2 + 3	=	6
1 + 2 + 3 + 4	=	10
1 + 2 + 3 + 4 + 5	=	15

What about : 1+2+3+4+.....+99+100 =?

Investigations : (a) Do you see any pattern? (b) Is the pattern always true; try with the numbers from 1 to 1000?

Hints : (a) Pair up the first and last term; then pair up second term from beginning and last and so on. (b) What is the sum of each pair? (c) How many pairs do you get? (d) Will it work for all the numbers?

Transition : (a) Write the pattern language for the above series. (b) Write the algebraic expression for it.

EXAMPLE 3

A diagonal from one vertex divides a quadrilateral into two triangles. The diagonals from one vertex divide a pentagon into three triangles (Quast, 1987). Complete the following chart.

Number of sides	4	5	6	7	8	..	..
Number of diagonals from one vertex	1	2	..	..	..	..	.
Number of triangles	2	3	..	..	..	..	..

Investigations : (a) What pattern do you see in the relationship between the number of diagonals and number of sides? (b) What pattern do you see in the relationship between the number of sides and the number of triangles?

Transition : (a) Write the pattern language for the above two generalisations discovered by you. (b) Write the algebraic expressions for the two generalisations.

In Conclusion

For an effective introduction of algebra, it should take off by creating an awareness of number patterns, relationships and generalisations. There is a wrong tendency on the part of most mathematics teachers in India to introduce algebra as a technique of finding the missing number or unknown quantity by transforming the problem directly into an algebraic equation. Perhaps such teachers do not recognise the power of symbolic

expression that can become alive to children through arithmetic patterns. The children can only appreciate the need of expressing patterns as generalisation when language is followed by algebraic expression.

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Learner Based Approach and Intrinsic Motivation for Better Education in Science

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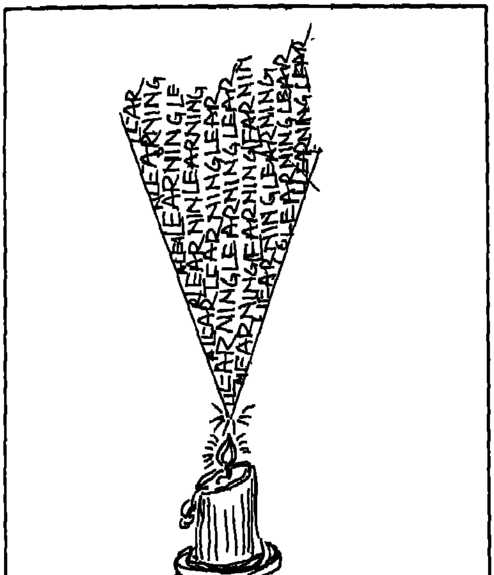

Numerous patterns and methods of education in science are in force nowadays, but most of them are basically teacher based approaches and content-centred in nature.

Extrinsic Motivation

Extrinsic motivation, as it is generally being used in these patterns and methods, often remains unable to motivate the learners to participate effectively, actively and whole-heartedly in the classroom teaching learning process. A better science teacher, as we all know is expected to know about the process of learning as and when he aspires to master the process of teaching. Extrinsic motivation facilitates learning for some time but later on its effect fades out. Thus, for effective education atleast in science subjects, impact of such type of motivation is not at all longlasting. We have to search out some other approach also as in the most of our schools, teacher based or teacher dominated approach is still in use for imparting education in science.

Need for Effective Strategy

We are very much familiar with the fact that learning is extremely personal in nature and a number of educational environment variables or input variables control the behavioral outcomes of the learners related to their cognitive, affective and psycho-motor domains. Therefore, an effective science teaching strategy is also required to be highly individualised on one hand and activity based or learner dominated on the other. Mere lecture-cum-demonstration and learners passive observation based group guidance style of teaching will be no more effective for better education in science subjects.

To develop scientific temper among the learners the input variables including cognitive and effective as well as social variables related with subjective

and interpersonal determinants of learning should also required to be controlled. The cognitive variable are depicted through the cognitive structure, developmental readiness, intellectual ability and habit of study and practice of the learners as well as the instructional/learning materials used by them whereas the effective and social variables are concerned with motivation, attitude, personality etc., and the group and social elements related with the learners as well as the characteristics of science teachers.

Intrinsic Motivation

Motivation is an important input variable of the educational system in general and the science education system, in particular. Since motivation is hidden in a person's psyche, in real sense, it originates internally. Thus, internal urge, personal interest and professional satisfaction are the basic elements which may enforce one to achieve the target of better education in science. Chilana (1991) very rightly remarked that it is upto the individual to discover the same, to rear it and to help it flower and flourish resulting in the life being more beautiful and satisfying. He has further clarified that to uncover and tap intrinsic motivation for professional growth, implies the personal thrust of a teacher which means his being deeply concerned about his professional self. In order that a teacher may involve his personal interest or personal satisfaction, it is necessary to awaken his internal urge for identifying himself with his work. He considered this as the best way to secure whole hearted devotion from an individual to action and involvement for achievement of psychological needs of acceptance, recognition and fulfilment.

Teaching profession is the real opportunity to develop internal capacities, abilities and full potential of a learner in all possible ways if he is able to recognise the value of internal incentives. In comparison to other professions, a teacher and prospective teacher may have ample opportunities, facilities and leisure time to spend in useful reading and creative writing beneficial for others as well as for himself which may lead him towards the development of professional skills and bring social recognition for him as a thinker and intellectual. His original contributions may not only make him the pioneer but will certainly motivate others to follow him and his novel way of thinking which ultimately culminates to raise the status of his profession in itself.

For inculcation of such motivation among the teachers and prospective teachers, now, it has been observed and accepted unanimously that the learner-based approach is eventually the ultimate.

Historical Perspective

If we evaluate in terms of historical perspective, it is obvious that the educational approach was basically either content centred or teacher centred from the very beginning. In ancient period, when religion was the dominating factor in education, the approach was content-based. The learners were expected to learn by heart, all of the content points irrespective of their own interest and liking. The same strategy is still in force more or less, in the form of course and curriculum. On account of expansion of

knowledge its various dimensions and fields, the formal teachers have acquired a strategic position. But the learners, the third pole of the tripolar process of teaching, is still in vogue and unattended. The same is the condition in case of prospective teachers too who are generally being expected to master the process, skills and techniques of teaching to be a good and successful science teacher. With the advent of psychological approaches in the field of teaching, the stress and thrust have been shifted from the curriculum and teacher to the learner, and from mastering the strategies of teaching to that of the learning. It has been perceived that teaching and learning are two different processes and understanding of learners and learning process is more significant for a teacher and prospective teacher than that of the teaching process.

Nowadays, a mid-way has been assumed to follow which has been termed as teaching-learning process, involving both the techniques of teaching and learning for better understanding of the learners and their capacity of learning as well as the success of teaching-learning communication which acts as an important source of intrinsic motivation to the teachers and the prospective science teachers. The role of them has eventually been changed due to this new approach. Technological advancement also has played a remarkably significant and changing role. A number of skills which were considered as essential for a good teacher and prospective science teacher in a decade ago, can be ignored well in this age of information processing, storing, depicting, duplicating and producing through a number of technical devices and when required in no time. Therefore, in the modern era, the teachers and prospective science teachers are facilitators and managers of learning experiences as well as organisers and planners of teaching learning situations to cause the students learn.

Learner-centred Approach

In the National Policy on Education (1986), it has been granted that the human beings are positive and real assets and the precious national resource which needs to be cherished, nurtured and developed with tenderness and care, coupled with dynamism. Each individual's growth presents a different range of problems and requirements at every stage — from womb to the tomb. The catalytic action of education in this complex and dynamic growth process needs to be planned meticulously and executed with great sensitivity.

To meet this end, institutes and centres of advanced study in education, district institutes of education and training, college of teacher education etc. have been designed and established progressively. Along with, to achieve the target of having better quality of education in science, development of a comprehensive and coherent learning system is considered to be essential and for this purpose learner-centred approach has been suggested by Singh and Sabharwal (1991), which requires inspired or intrinsically motivated teachers and prospective science teachers as main functionaries who often may use methodical skills in teaching and seek new ideas, more effective and relevant to their own situation for adoption and application accordingly.

This learner-based approach implies that the learners, their needs, requirements and abilities are supreme and above all other elements like teachers, syllabus and curricular limitations. Thus, in this approach, the teacher acts as a facilitator of learning, the curriculum remains flexible and its completion within a specific time limit becomes redundant. Development of mental abilities and power of implication among the learners is more valuable than that of acquisition of informations and knowledge. National Curriculum for Elementary and Secondary Education — A Framework (1989), has also stressed upon stimulation of clarity and independent thinking, development of problem solving skills, promotion of planning and execution of projects and self learning involving acquisition of knowledge through observation of creative thinking and activities.

This approach has also been recommended in NPE (1986) and suggested to build the academic programmes and school activities around the need, interest and aptitude of children. This approach is oriented towards all-around development of the learners and thus requires flexible curriculum which may consist of some future oriented concepts like preservation of environment, conservation of natural resources, small family norms to get rid of the problem of over population, inculcation of values and preservation of cultural and racial heritage, natural identity and unity, equality of opportunity among all members of society, etc., for development of logical reasoning, ability of scientific analysis and creative thinking among the learners.

Inculcation of Intrinsic Motivation

Development of learning awareness among the learners is necessary to attain this target of high esteem and for this intrinsic motivation is the only way of out. Motivation, as considered by Atkinson (1964) refers to the arousal of tendency to act to produce one or more effects. This concept as developed by Descartes in 1949 explains that the nature has given animal and human being remarkable constitution which generates right kind of behaviour, attitude, desire and readiness to perform those task which promote their welfare. This is possible through a number of extrinsic as well as intrinsic factors.

Bernard specified that it includes all those phenomena which are involved in the stimulation of action towards particular objectives where previously there was little or no movement towards these goals.

Harlow and associates (1950) had developed a theory of intrinsic motivation according to which intrinsic drives like manipulatory, exploratory and curious behaviour of human and subhuman beings are the real motives which could make learning more efficient, stable, constant and continuous. These drives may be aroused by external conditions which motivate one for action but mere extrinsic drives are not sufficient to promote learning.

To motivate the learners in the formal teaching-learning situation some such conditions and principles found much useful like principles of pleasure and pain, which ascertains provision of pleasant and satisfying experiences for sustenance of positive learning

behaviour; use of rewards and punishment — as material symbolic and psychological rewards bear a positive impact in motivation for learning and creating learning desire and awareness; appropriating the level of aspiration of learners, i.e. tailoring of the classroom activities and programmes in accordance with the aspiration levels of learners; using friendly relationship rather than rivalry to develop a sense of cooperation and feeling of healthy competition among various learners as a strong incentive for motivation and using knowledge of the results or performance of the learner's work or feedback as a motivating force in learning task to improve content mastery of learners.

Bringing novelty or providing knowledge of new and unknown things or events is another significant strategy to facilitate motivation and permit them to move into ever new fields of exploration to enhance their curiosity and interest and thus arouse a desire for self-learning through experimentation and avoid anxiety tension raising as well as stressful procedures. Such strategy may be applied in the symbolic and simulated model situations e.g. mathematical games, video games, story completion, drawing figures and diagrams using computers, etc.

To inculcate intrinsic motivation among learners another strategy may be to create psychological and social needs for learning through relating various classroom activities to their future life and problems. For this purpose, discussion method and developmental task, programmed learning texts and materials, tutorials and team teaching etc., are some of the significantly useful techniques which could be used successfully while teaching science and providing training to draw and develop new interpretation of facts and figures.

The primary level learners are imitative and learns basically through physical activities and observation of elements around them in the neighbouring environment i.e. at home and school, on account of their curiosity and interactiveness with their environment, whereas at secondary level they become less anxious due to enhancement of self confidence, self dependence and desire to learn more nonverbal and abstract concepts as well as skills than that of verbal and concrete concepts only.

Science Teacher as a Guide and Motivator

Thus, the teachers and prospective science teachers require to understand that their role is of a guide and motivator of learning activities at primary level through provision of desired learning experiences to satisfy the queries and dilemmas of learners. Activity based teaching strategies are found more suitable at this stage.

At the next higher level, the teacher and prospective science teachers become the facilitator of learning and creator of a specific teaching-learning situation in which the learners can develop and use their power of observation, analysis, logical reasoning and drawing conclusion through active participation in classroom interaction and activities to acquire knowledge, develop understanding and learn skills for application of learning experiences in real life or model situation.

Development and enhancement of

the level of self-concept, improvement of self-image and concern for excellence, power of imagination and a craze to have unique attainment, self-management and control and a desire to be slave of one's own self rather than that of others, etc., are the ways to bring ultimately the learners at the level of self-motivation.

Conclusion

For better education in science as well as for preparation of better prospective science teachers, the learner-based approach thus seems to be inevitable since it is the basic way to develop scientific temper and reasoning ability among the learners. Professional growth of science teachers is only then be possible when they will be ready to make some efforts to inculcate self-motivation among their students along with a desire to know more be aware of numerous day-to-day incidents and ability to give some new interpretation of their own for them and develop a sense of responsibility. The external incentive could be used only as the means to meet this end and not as the ultimate objective of education in science.

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Objective Questions in Organic Chemistry

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Section A

Choose the correct answer :

1. Unsaturated compounds such as alkenes, alkadienes and alkynes exhibit one of the reaction :
   (a) nucleophilic addition
   (b) Electrophilic addition
   (c) Electrophilic substitution
   (d) nucleophilic substitution
2. Tertiary butyl chloride on Wurtz reaction yields :
   (a) 2,3-dimethyl butane
   (b) 2,2'3,3' tetramethyl butane
   (c) 2,2',3,3'-tetramethyl octane
   (d) 2,2,3' tri methyl butane
3. Isobutyl magnesium chloride on hydrolysis yields isobutane where as isopropyl magnesium chloride forms :
   (a) isopropyl chloride (b) ethane
   (c) n-propane (d) no reaction
4. Ethyl alcohol on reaction with sodium forms sodium ethoxide. This on reaction with methyl chloride gives an
   (a) aldehyde (b) ketone (c) ether
5. Ethylene on addition with HCl forms a compound 'x'. This on Wurtz reaction yields n-butane. Hence compound 'x' is :
   (a) methyl chloride
   (b) dichloro ethane
   (c) ethyl chloride
   (d) n-propyl chloride
6. Calcium carbide on hydrolysis yields the alkyne, acetylene. This compound on strong heating forms :
   (a) diacetylene (b) benzene
   (c) ethylene (d) toluene
7. Isobutene upon addition of HCl forms compound 'x'. This reacts with magnesium in ether solvent to form :
   (a) Isobutyl magnesium chloride
   (b) n-butyl magnesium chloride
   (c) ter-butyl magnesium chloride
   (d) sec-butyl magnesium chloride
8. The percentage of bromine in tribromo phenol is
   (Atomic weights : C=12, H=1, O=16, Br=80)
   (a) 72.5 (b) 7.25 (c) 145 (d) 725
9. Two cylinders contain ethylene and acetylene. By what qualitative test can one confirm the presence of acetylene in one of them ?
   (a) decolourisation of bromine in CCl (b) decolourisation of potassium permanganate (c) passing the gas in ammonium cuprous chloride solution (d) hydrogenation
10. An unknown compound is insoluble in water. However, on refluxing with sodium hydroxide it yields sodium acetate and sodium phenoxide. The unknown compound is
    (a) benzyl acetate (b) phenyl acetate (c) ethyl acetate (d) phenyl benzoate.
11. An unknown olefin on ozonolysis yields one mole of acetone and one

mole of acetaldehyde. The original structure of oleffin is :
(a) propene (b) 2-butene
(c) 2-methyl-2-butene
(d) 2,3-dimethyl-2-butene

12. An unknown alcohol 'A' on oxidation yields an aldehyde 'x' which upon further oxidation yields an acid 'Y'. Both the compounds 'X' & 'Y' show positive reducing test. Hence compound 'A' is :
(a) ethanol (b) propanol (c) methanol (d) none of these

13. Oxidation of methyl benzene with alkaline $KMnO_4$ yields benzoic acid. The oxidation product of ethyl benzene is :
(a) Phenyl acetic acid (b) salicylic acid (c) no reaction (d) also benzoic acid

14. Compound 'A' reacts with sodium nitrite plus HCl, i.e., nitrous acid to form 'B'. Compound 'B' is a neutral compound. This reacts with sodium and on further reaction with methyl chloride forms ethyl methyl ether. Compound 'A' is :
(a) ethyl alcohol (b) ethyl amine
(c) methyl amine (d) acetamide

15. The molecular weight of chloro benzene is (Atomic weights : C=12, H=1, Cl=35.5) :
(a) 11.25 (b)112.5 (c) 225 (d) none of these.

Section B

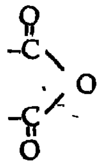
Answer the following in few sentences :

16. Why alkenes and alkynes are more reactive than alkanes?
17. Why benzene is a stable compound?
18. What is peroxide effect ?
19. Why halogenation of methane is termed as a chain reaction?
20. Why alkyl magnesium halides are unstable in water?
21. Why alcohols have a higher boiling point than their corresponding ethers?
22. What is meant by a polymer? Give an example.
23. What is the product obtained after Wurtz reaction?
24. Which one is acidic : ethanol or phenol? Why?
25. Which one of the amines lack a free hydrogen at the nitrogen atom?
26. What is saponification?
27. What are conjugated alkadienes? Give an example.
28. What product is obtained upon catalytic hydrogenation of benzene?
29. Why trichloroacetic acid is stronger than acetic acid?
30. Name the products of ozonolysis of 2-pentene.
31. Give the structural formula of 2, 3-dimethyl-4-chloro-2-ene 5-yne-n-octane.
32. Why aniline is less basic than methylamine?
33. Which one of the isomeric alcohols of C_4H_9OH is optically active?
34. What is oil of winter green?
35. What is mestoic acid?
36. Name two base catalysed reactions of aldehydes and ketones.

37. What is a carbonium and carbanion?
38. Expand $S_N{}^1$ reaction?
39. Expand the abbreviation DDT.
40. What is gammaxene?
41. Why are ethers and esters insoluble in water?
42. Distinguish acetone and acetaldehyde by a qualitative test.
43. What is the oxidised product of 1.2 dimethyl benzene with alkaline $KMnO_4$?
44. What does vinyl chloride on polymerization yield?
45. What type of alkenes will obey Markovnikov's rule?
46. Addition of water to ethylene yields ethyl alcohol. A similar addition to acetylene in the presence of mercuric sulphate (catalyst) yields?
47. Distinguish aniline and ethyl amine by a qualitative colour reaction.
48. What is cumene?
49. Why nitrobenzene upon nitration yields m-dinitrobenzene?
50. Name an acid halide and an amide of acetic acid.

Section C

Match the following :

Functional Group	*Class*
51. $>C=C<$	Aldehyde
52. $-C\equiv C-$	Acid
53. $-\underset{\underset{H}{\vert}}{C}=O$	Alkyne
54. $-\underset{\underset{H}{\vert}}{C}=O$	Alkene
55. $-\underset{\underset{NH_2}{\vert}}{C}=O$	Ester
56. $-\underset{\underset{OR}{\vert}}{C}=O$	Amide
57. $-\underset{\underset{X}{\vert}}{C}=O$	Mercapton
58. $-C\equiv N$	Acid halide
59. $-{}^{+}N\equiv C^{-}$	Alcohol
60. $-S\ H$	Alkadiene
61. $-O\ H$	Isonitrile
62. $-Mg-X$	Thio ether
63. $-C=C-C=C-$	Ether
64. $R-O-R$	Primary amine
65. $R-S-R$	Ketone
66. $-\underset{\underset{H}{\vert}}{N}-H$	Alkyl magnesium halide
67. $-\underset{\underset{R}{\vert}}{N}-H$	Tertiary amine
68. $-\underset{\underset{R}{\vert}}{N}-R$	Anhydride
69. $\begin{matrix}R\\R\end{matrix}{>}C=O$	Secondary amine
70. 	Nitrile

ANSWERS

Section A

1.b 2.b 3.c 4.d 5.c 6.b 7.c 8.a
9.c 10.b 11.c 12.c 13.d 14.b 15.b

Section B

16. Alkenes and alkynes are more reactive than alkanes due to unsaturation.

17. Benzene is a stable compound owing to resonance.

18. The influence of peroxide on the addition of hydrogen halide to unsymmetrical alkenes is known as peroxide effect. The product obtained is opposite to that of normal addition or Markovnikov's rule.

19. Chlorination of methane is termed as a chain reaction because it yields a mixture of halides such as methyl chloride, methylene chloride, chloroform and carbon tetra chloride.

20. Alkyl magnesium halides are unstable in water as they undergo hydrolysis to yield alkanes.

21. Alcohols have higher boiling point than their corresponding ethers due to intermolecular hydrogen bonding.

22. A long chain of a repeating unit (monomer) is termed as polymer. Ex : Polythene.

23. The product obtained after Wurtz reaction is a higher alkane. Ex : methyl chloride upon Wurtz reaction forms ethane.

24. Phenol is acidic whereas ethanol is neutral because of resonance stabilization of the phenoxide anion. No such resonance stabilization is observed in ethanol.

25. Tertiary amines lack a free hydrogen at the nitrogen atom.

26. The hydrolysis of fat with sodium hydroxide or potassium hydroxide to glycerol and sodium or pottasium salt of a long chain fatty acid (soap) is known as saponification.

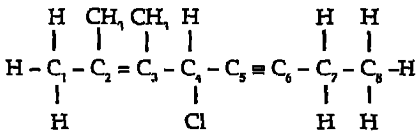
27. Alkadienes with alternate double bonds are known as conjugated alkadienes. Ex : 1, 3 butadiene.

28. Cyclohexane, a cycloaliphatic compound with a molecular formula of C_6H_{12} is obtained after catalytic hydrogenation of benzene.

29. Trichloro acetic acid is stronger than acetic acid due to the influence of chlorine, the electron withdrawing group. This has an effect on the dissociation of H^+.

30. The products of ozonolysis of 2-pentene are acetaldehyde and propanaldehyde.

31.



32. Aniline the primary aromatic amine is less basic than methyl amine because of election donating nature of amino group and resonance.

33. Four isomers of C_4H_9OH are possible namely n - butyl alcohol, sec - butyl alcohol, iso butyl alcohol and ter-butyl alcohol. Among these, only sec-butyl alcohol is optically active as it has an asymmetric carbon atom.

34. Oil of winter green is methyl salicylate.

35. 2,4,6 trimethyl benzoic acid is mestoic acid.

36. Canizarro's reaction and aldol condensation are two base catalysed reaction of aldehydes and ketones.

37. A positively charged carbon is known as carbonium ion and a negatively charged carbon is known as carbanion.

38. Substitution nucleophilic unimolecular.

39. Dichloro diphenyl trichloro ethane.

40. The gamma isomer of hexachloro benzene is gammaxene.

41. Ethers and esters are insoluble in water due to lack of hydrogen bonding.

42. Acetone and acetaldehyde can be qualitatively distinguished by Silver mirror test or Tollen's test.

43. The oxidised product of 1, 2, dimethyl benzene is phthalic acid.

44. Vinyl chloride on polymerization yields polyvinylchloride.

45. Unsymmetrical alkenes such as propene 1-butene obey Markovnikov's rule.

46. The hydrated product of acetylene is acetaldehyde. The same is obtained by tautomerism of vinyl alcohol.

47. Aniline shows a positive red dye reaction. The test is negative for ethyl amine.

48. Isopropyl benzene is cumene.

49 Nitration of benzene yields m - dinitro benzene because nitro group is a meta directing group.

50. The acid halide and amide of acetic acid are acetyl chloride and acetamide, respectively.

Section C

51. Alkene 52. Alkyne 53. Aldehyde 54. Acid 55. Amide 56. Ester 57. Acid halide 58. Nitrile or cyanide 59. Isonitrile or isocyanide 60. Mercaptan 61. Alcohol 62. Alkyl magnesium halide 63. Alkadiene 64. Ether 65. Thio ether 66. Primary amine 67. Secondary amine 68. Tertiary amine 69. Ketone 70. Anhydride.

Science Crossword Puzzle

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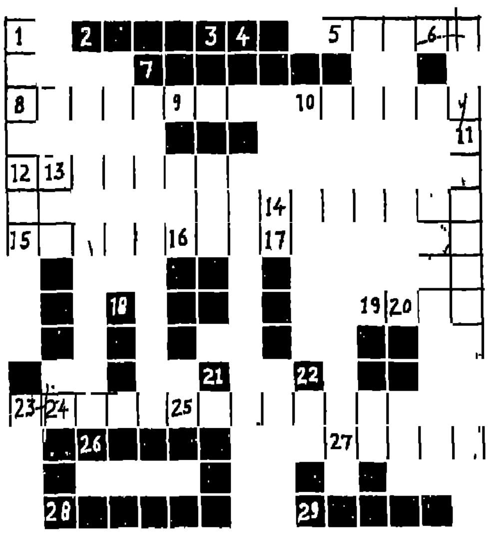
The following crossword puzzle has 29 words. All of them are names of world famous scientists. It may be full name, popular name, or the abbreviated names. Simple clues to solve the puzzle are given. The figure in the brackets indicates the number of letters in that name.



Across

2. First Indian scientist to receive Nobel Prize (7)
5. Italian physicist who conducted the first controlled chain reaction and discovered a new radio isotope (5)
7. Who discovered penicilin (7)
8. German physicist and first recipient of Nobel Prize in physics who discovered X-rays. (7)
10. German physicist and Nobel Prize winner gave an expression which represents the radiation curve over the entire wavelength spectrum (6)
12. An English scientist who gave atomic theory (6)
14. English scientist who gave theory of electro-magnetic waves (7)
15. An English physicist who gave theory of colour vision and studied the interference (5)
16. Yugoslav scientist who conceived the idea of rotating magnetic field and invented the induction motor (5)
23. The SI unit of work is named after his name (5)
25. French physicist who measured the speed of light in matter (8)
26. Danish physicist who explained the spectrum of hydrogen atom based on quantum theory (4)
27. German physicist who produced electromagnetic waves and send them through space (5)
28. Indian physicist and plant physiologist who produced ultrashort radio waves and invented highly sensitive instrument to detect the minute responses by living organisms (6)
29. Who gave the laws of refraction of light (5).

Down

1. A British scientist who discovered the laws of electromagnetic induction (7)
3. Who gave the modern periodic table (9)
4. French physicist who formulated the law of magnetic force between electric currents (6).
6. American experimentor who measured the speed of light with improved accuracy (9)
9. German physicist who asserted the equivalence of mass and energy (8)
11. Italian scientist who gave the principle of inertia (7)
13. French scientist who said that equal volume of all gases contain equal number of molecules (8)
17. Gave a law to find the direction of induced emf (4)
18. Found the inverse square law of electrostatic force (7)
19. German physicist known for his discovery of the laws of planetary motion (6)
20. An engineer who improved the steam engine (4)
21. A chemist who worked on the electrolysis of organic compounds (5)
22. Who along with Wilheln Welser built the first electric telegraph (5)
24. Worked on flow of electricity in the conductors and gave a law to determine resistance of conductors (3).

ANSWERS

Across	*Down*
2. C.V. Raman (7)	1. Faraday (7)
5. Fermi (5)	3. Mende Leef (9)
7. Fleming (7)	4. Ampere (6)
8. Rontgen (7)	6. Michelson (9)
10. Planck (6)	9. Einstein (8)
12. Dalton (6)	11. Galileo (7)
14. Max Well (7)	13. Avogadro (8)
15. Young (5)	17. Lenz (4)
16. Tesla (5)	18. Coulomb (7)
23. Joule (5)	19. Kepler (6)
25. Foucault (8)	20. Wett (4)
26. Bohr (4)	21. Kolbe (5)
27. Hertz (5)	22. Gauss (5)
28. J.C. Bose (6)	24. Ohm (3)
29. Snell (5)	

Teaching Science through Low-cost Apparatus at Primary Level

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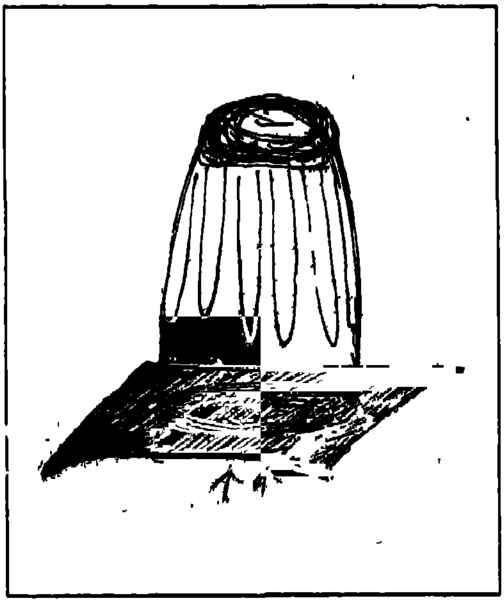


The word 'science' is derived from the Latin word 'science' meaning knowledge. The term 'science' in its broad sense embraces all forms of systematised knowledge. According to the eminent scientist and philosopher Albert Einstein, science is something exciting and complete, the most objective thing known to man. In the ancient period, science confined to the earliest mathematical and astronomical documents, was taught by priests and scribes in monasteries and temple schools. Science was not a subject on its own and constituted only a part of religious and philosophical doctrines.

Science has continuously changed its contours and dimensions along with the onward march of civilization. Science by its nature does not climb on an ascending straight path, but moves in a zig-zag fashion corresponding to the phase of rapid advancement and doctrine-teaching (a thing taught). Everyone today needs to understand what science is about. We need it because science affects many aspects of our society at present. Especially the students need a good foundation in science at the school level. It is therefore for the science teachers at the school level to play proper foundation for understanding of science. If science is taught badly it not only degenerate into superstition but makes negative contribution to education (Kothari). Therefore, it is necessary that every science teacher in this country should plan for good foundations in science to become a socially acceptable teacher. The work is not easy. It is painstaking time-consuming but extremely exciting and satisfying if undertaken with right spirit.

The role of a teacher in educational system is pivotal and therefore, the success of any educational system rests on its teachers. Teachers introduce a subject in a meaningful way, lay solid foundations and on these foundations raise the

tower of knowledge properly and firmly.

The world is advancing rapidly with scientific and technological achievement. So, it has become necessary for the students to learn science not only for developing pragmatic outlook but also for getting rid of superstitious and orthodoxy of casteism, racism etc. Thus, promotion of scientific attitude and outlook in the minds of the students should be the first task of a science teacher. Without scientific attitude and outlook a student cannot appreciate the achievements of science and its role in modern civilization.

The success of teaching science consists in (i) selection of curriculum, (ii) teaching method, and (iii) proper evaluation. In respect of selecting a proper curriculum of science particularly for the primary stages of education, we may refer to the recommendation of the Mudaliar Commission (1953): "Curriculum does not mean only the academic subjects traditionally taught in schools but includes the sum total of experiences that a pupil receives through the manifold activities in school, in the classroom, library, laboratory, workshop, playgrounds and in the numerous informal contacts between teachers and pupils". In other words, the science curriculum for a beginner should be based on the findings and experiences which he may gather from his surroundings. However, we may also consider the suggestions of Jann Piaget regarding different phases of the mental change of a student for successful implementation of a proper curriculum of science. Piaget has suggested that a child in the age group 2 to 7 or 8 remains in preoperational stage, 7 or 8 to 11 or 12 in concrete operational stage, 11 or 12 onwards in formal operational stage. He also held the view that in the pre-operational stage a beginner can recognize an article through its size, volume, colour etc. In the concrete operational stage a child (student) can determine the inter-relation among different happenings around him or her and hence can compare and classify them. Abstract reasoning grows in the formal operational stage of a student. It is expected that, one should select a curriculum the method of teaching and the subject suitable for the students commensurate with the stage of development of the student. From the above discussion it seems that teaching science at the primary stages should be motivated in such a way that the concepts of science grow in the mind of the student on the basis of the concrete experiences of his/her daily life. One cannot, however, ignore the presentation of the key concept of science to the students of primary and middle classes. Moreover, if the key concepts of science are developed in the beginning, it would be easy to teach the subject at secondary and higher classes.

From the above discussion it seems that science should be taught in such a way that a comprehensive picture of the subject clearly emerges before the learner even in the beginning. Otherwise the possibility of memorising facts related to any topic of the subject will dominate in the student. This is likely to adversely affect the development of the students during their concrete operational stage. Hence a student is likely to face difficulties at the formal operational stage. Thus, it seems most appropriate that a beginner in the learning of science be taught through practical demonstration and by using easily available low cost materials. This may

lead to the development of critical insight which is practically the result of instinct and spontaneous intention of learning.

Some Activities

Kitchen centre teaching is an effective guide to modify the behaviour pattern of elementary school children to the needs of our nation. Kitchen provides us a wide range of experiences which could be utilised to encourage them to explore freely. Activities in the kitchen provide a child basic experiences and the children become more curious to explore.

We have taken here some of the activities based on the processes that go on in a kitchen to justify the above statement. For example on heating water, it absorbs heat and begins to boil. A phenomenon which a child usually observes in every kitchen. Here the child is observing the molecular interaction, up and down movements of relatively hot and cooler water molecules. He can also be explained that water boils at a certain definite temperature and forms steam. From this the child can be led to generalise that water changes its state on heating.

A child often drinks water from the earthen pot and finds it cool. This experience through his sense organs could be used to motivate him to find out the cause of cooling. He can be told to observe the pot carefully and note the minute pores on it. One can easily demonstrate that the process of evaporation causes cooling by putting a few drops of water on the back side of hand and blowing air over it. This experience could be related with the cooling of water in an earthen pot. Similarly the role of steam in preparation of *idlies*, pressure cooker, rice cooker and steam engine, can also be discussed to bring out principles of science which facilitate these processes. For example in a pressure cooker cooking becomes easier and faster because of the fact that a large amount of steam is produced in it increases the pressure inside which results in the rise of the boiling point of the water.

Milk is another constituent used in the kitchen. It is used for making tea. Mixing of tea leaves in the boiling water and then adding milk and sugar in certain proportion is a good example for mixture. A child usually sees his/her mother cooking food by burning wooden sticks or some other fuel. The concept of chemical change and combustion can be explained with the help of this experience. The idea of physical change can be similarly explained with the example of melting of ice or wax in a candle. Many more such interesting experiences can be utilised for teaching concepts of science to a child in elementary school.

Usually a child observes his/her mother washing clothes and drying them. The concept of evaporation can be explained with this example. The factors that accelerate evaporation can also be brought out by simple demonstrations. The following questions can be raised in order to discuss the concept of evaporation.

1. How does water disappear?
2. Where does the water of wet clothes go?
3. What are factors that makes the evaporation faster?

A teacher can also motivate children to compare the rate of evaporation on a dry day with that on a wet/rainy day.

Mostly in winter morning a child observes the water droplets on grass and on green leaves of other plants. A teacher can raise the following questions to explain the concept of condensation:

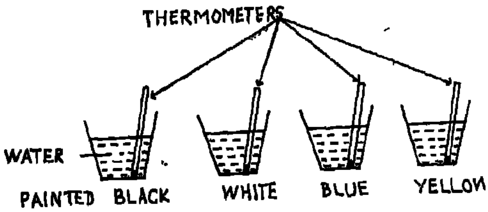
1. What is the cause of formation of these water droplets?
2. When do you notice such a phenomenon?
3. Why does condensation take place?

Construction of compost pit for depositing the waste from the kitchen, its conversion in the form of manure, its application in kitchen garden, vegetable cultivation near the kitchen, gardening, pumping, use of motor pump for pumping water from deep well are some other day-to-day experiences that can be fruitfully utilised to develop concepts of science.

All these activities are based on certain scientific laws and principles. Thus formation of concepts through practical experiences, including the basic ones is essential for the proper understanding of science. This approach will certainly help the primary school children. This process is natural, less expensive and will satisfy the children's needs. Some of the scientific concepts which can be explained to the children through activities using available low cost material are as follows.

Thermal Radiation Absorption

Take four tin cans and paint them black, white, blue and yellow. Fill the can half with water. Put a thermometer into each of the can. Place them in the sun for half an hour and find the rise in temperature of water in each one of them. Repeat the same experiment in the laboratory using room heater.



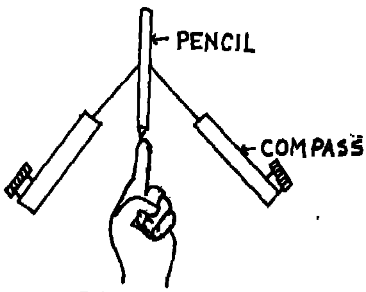
Investigations

1. Investigate how does the rise in temperature vary with time for the surface of a given colour.
2. Investigate how the rise in temperature varies with the colour of the surface.

Centre of Gravity Toy

1. Take a pencil and two compasses.
2. Poke into the pencil the two compasses slantingly at 5 cm away from the tip of the pencil.
3. Balance the pencil now on the tip of your finger.
4. Shake the pencil slightly.
   What do you observe?
   Why is it so?

Discuss the possible reasons to explain your observations in this situation? Suggest an investigation that can be done.



Upthrust of Water

Take a scale from your geometry box. Make a loop of a piece of thread and suspend the scale by inserting it in the loop. Take an eraser and hang it with a thread from one end of the scale.

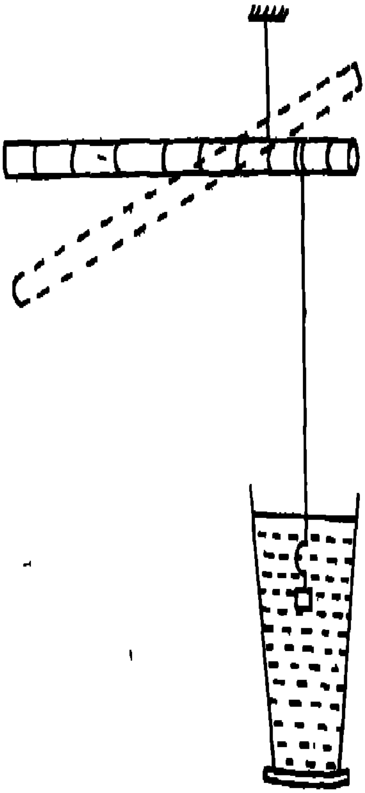
Move the thread loop so that the scale is balanced .

Take a beaker full of water and allow the eraser to emerge in water.

What do you observe?

Why is to so?

Suggest an investigation that can be done.



Trigonometric Scales

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IF you continue to seek and discover the wonders, you will encounter a variety of things, ideas that lie in wait at every nook and cranny of this amazing world.

A simple hand-made model to read the values of all trigonometric ratios.

While teaching secondary section, we have come across problems of the type :

Ex : Solve for x

(i) $1.732 = x/0.9947$

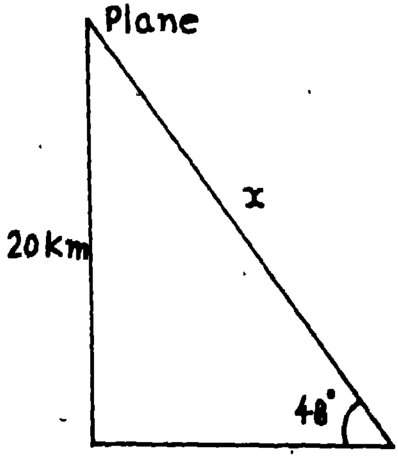
(ii) $0.4678 = 5.392/x$

In the first case, we have to find the value of x by cross multiplication, and the second problem x should be found out by division.

I think you will definitely agree that multiplication is easier than division so, to find any known x, it must occur in the numerator, so as to get its value by simple cross multiplication.

While teaching heights and distances in Class X, we have come across the problems of the type :

Ex : A plane is observed to be approaching the airport. Its height above the ground, when observed was 20 kms, and was making an angle of 48° at the point of observation. Find the distance of the plane from the point observation.



From Fig.2 :

$x/20 = \text{Cosec } 48^\circ$

$\therefore x = 20 \text{ Cosec } 48^\circ$

Here, if unknown x has to be brought in the numerator then we must know the value of Cosec 48°, (which is not given in the log book). Otherwise we have to get reciprocal of sin 48° (which is rather difficult). Or we have to find x by using logarithms (which will be time-consuming in this simple case).

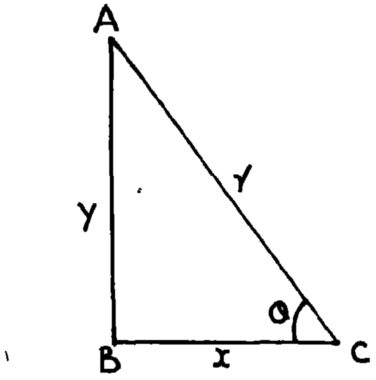
Therefore, a question comes to our mind. 'Is there any easy method to find our trigonometric ratios'. And the answer is YES.

Let us see the following sample.

Theory :

Sin θ = Opposite side/hypotenuse = y/r

Cos θ = Adjacent side/hypotenuse = x/y



Tan θ = Opposite side/Adjacent side = y/x
Cot θ = Adjacent side/Opposite side = x/y
Sec θ = Hypotenuse/Adjacent side = r/x
Cosec θ = Hypotenuse/Opposite side = r/y

Principle : We take denominator as one unit, so that the values of numerators can be obtained the direct scales.

Materials

(i) Cardboard or hardboard of size 40 cms x 45 cms

(ii) Graph paper 30 cm x 40 cm.

(iii) A protractor, a piece of thread and drawing pins.

Procedure

(i) Paste the graph paper on the cardboard as shown in Fig. 1.

(ii) Draw x, y axes and a circle of 20 radius (i.e. 1 unit), with centre at origin O, when the scale is 2 = 0.1 unit.

(iii) Graduate the axes and tangent lines drawn through points (1,0) [parallel to y-axes] (0,1) [parallel to x - axes]

(iv) Name the lines as in Fig. 1

(v) Fix a protractor with a drawing pin at the origin and tie a piece of thin polyester thread to the head of the pin.

How to Read

(i) Stretch the thread along x-axis and coincide it with 0° angle of the protractor.

(ii) Rotate it along the arc up to the desired angle θ is formed between the thread and x-axis.

(iii) Put a pin say 'P' on the point of intersection of the arc and the thread, another pin say 'S' on the point of intersection of this thread and line As, and pin say 'L' on the point of intersection of the same thread and line Bi.

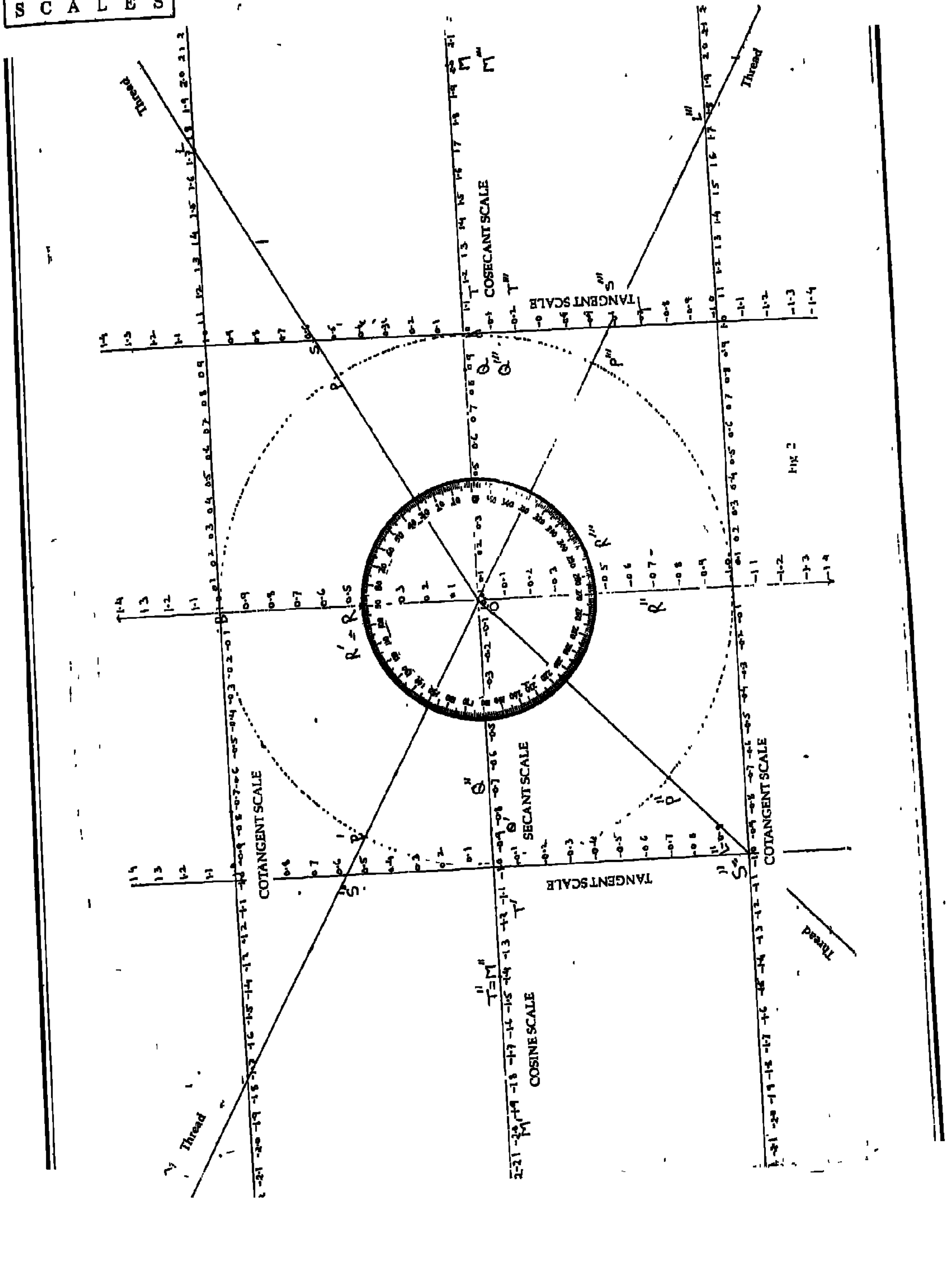
(iv) The position of point (pin) S will directly give the value of tan θ on tangent scale.

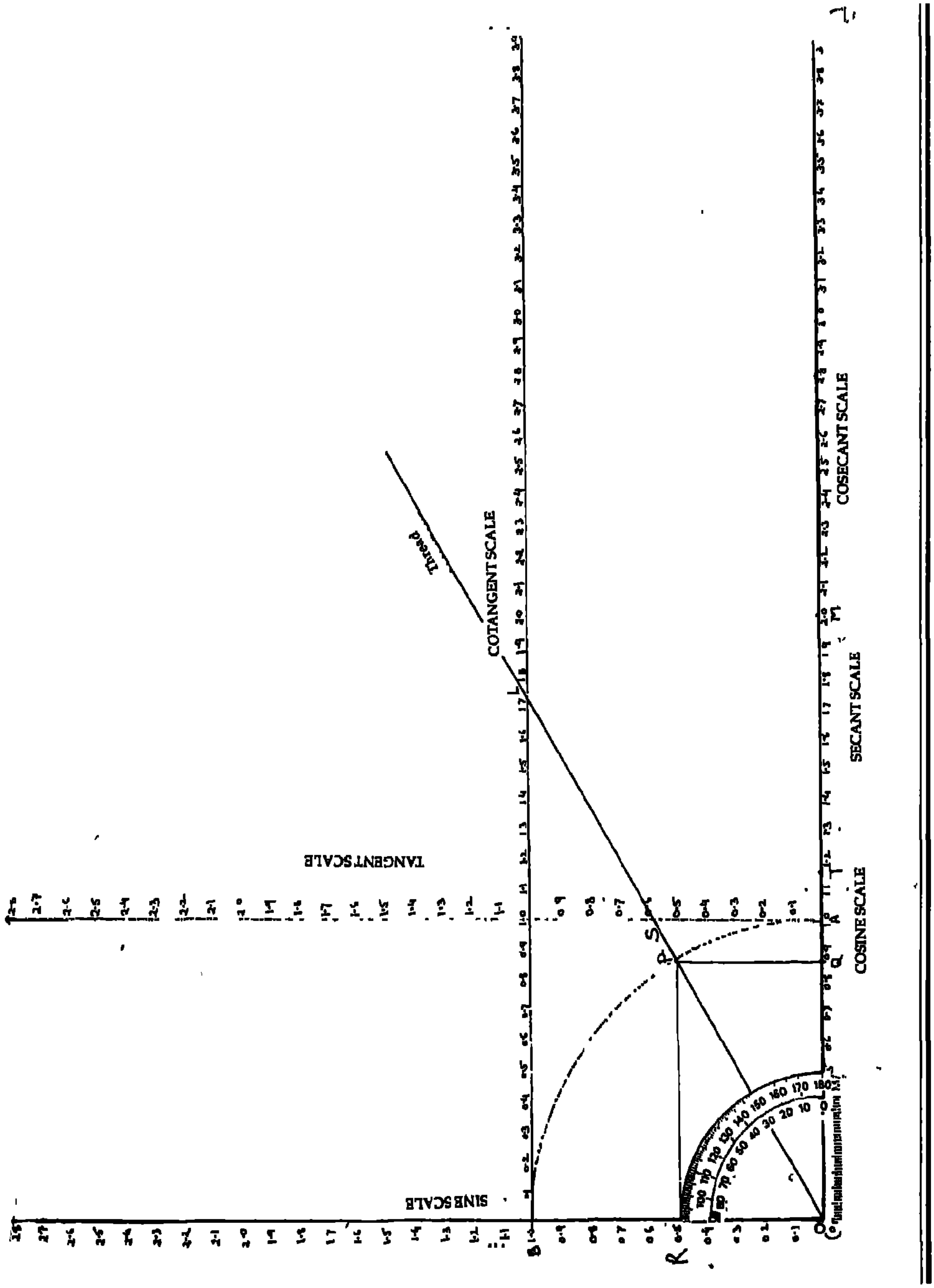
(v) The position of pin L will directly give the value of cot θ on the cotangent scale.

(vi) Draw perpendiculars on x-axis and y-axis from point P i.e. pin Q and pin R respectively.

(vii) The points of intersection of these perpendiculars with x-axis and y-axis will give values of cos θ and sin θ respectively.

(viii) Now hold the thread tightly at point S and rotate the thread in clockwise direction; so that point S coincide


COSECANT SCALE
TANGENT SCALE
COTANGENT SCALE
SECANT SCALE
TANGENT SCALE
COTANGENT SCALE
COSINE SCALE
Thread
Thread
Thread
Thread
Fig 2


COTANGENT SCALE
COSECANT SCALE
SECANT SCALE
COSINE SCALE
TANGENT SCALE
SINE SCALE
Thread
L
M
T
A
Q
P
S
R
B
O

with point T on x-axis which will give the value of sec θ directly.

(ix) Hold the thread tightly and point L and rotate the thread in clockwise direction so that the point L coincide with point M on x-axis, which will give the value of cosec θ directly.

With the help of the model one can find correct values of all trigonometric ratios up to 3 places of decimals. But, we will have to allow for the possibility of instrumental errors in such hand-made devices.

Limitations

We cannot read the values of tan 90° cot 0°, sec 90° = cosec 0°, etc. on this graph paper as we need infinitely long graph paper.

Extended Model : The same mode can be extended to angles greater than 90°. See Fig. 2.

SECOND QUADRANT

(i) Rotate the thread up to desired angle θ > 90° (in Fig. it is 150°).

(ii) Thread interests the arc of one unit in P′ tangent scale in S′ and cotangent scale in L′.

(iii) Foot of the perpendiculars from point P′ on negative x-axis and positive y-axis i.e. Q′ and R′ will give (i.e. read) the values of cos θ and sin θ respectively.

(iv) Point S′ read the value of tan θ directly by attaching negative sign to it.

(v) Point L′ will read the value of cot θ.

(vi) The lengths OS′ and OL′ will give numerical values of sec θ and cosec θ respectively. So hold the thread tightly at S′ (or L′) and rotate it till it coincide with point T′ (or M′) on negative x-axis, T′ will read the value of sec θ and M′ with only numerical value will read the value of cosec θ.

THIRD QUADRANT

(i) Point Q″ (R″) on negative x-axis (y-axis) read the value of cos θ (sin θ).

(ii) Numerical values of point S″ (L″) on tangent (cotangent) scale will read tan θ (cot θ)

(iii) Point T″ (M″) give the value of sec θ (cosec θ) on negative x-axis after rotating length OS″ (OL″) till S″(L″) coincide with T″(M″).

FOURTH QUADRANT

(i) Point Q‴ (R‴) on x-axis (negative y-axis) read the value of cos θ (sin θ).

(ii) Points S‴ (T‴) on tangent scale (x-axis) will read the values of tan θ (sec θ).

(iii) Values represented by point L‴ (M‴) on cotangent scale (x-axis) when read by attaching negative sign, will give the values of cot θ (cosec θ).

Science News

New Look at the Quarks

Eminent science writer Nigel Hawkes of *The Times* London, has described the repurcussion of a new experiment recently reported from Fermilab, the U.S. accelerator laboratory near Chicago, as one similar to Rutherford's finding about atoms at the turn of the century.

It is well known that Rutherford demonstrated that atoms were largely empty space with a solid core, the nucleus.

The results of the new experiment indicate that the quarks, which have inherited the atom's mantle as the fundamental particles of matter, may actually be made up of something even smaller.

If so, one of the most resilient theories of science, the so-called standard model, may have to be jettisoned.

The model, which emerged about 20 years ago, has had a brilliant career, explaining result after result with stunning precision.

The standard model says that matter is made up of six quarks, six leptons (the electron, muon and tau, plus their neutrinos) and their antiparticles. Quarks form groups of two or three, bound together to make particles such as the proton and neutron.

The new results have emerged on the horizon like a cloud no bigger than a man's hand. They come from experiments in which protons and antiprotons are collided at high energy, and 'jets' of particles emerge at large energies and angles.

The standard model, or a component part of it, called quantum chromodynamics, or QCD, predicts these jets remarkably well.

The jets are the nearest we ever get actually to seeing quarks and gluons (the particles that carry the strong nuclear force).

At low energies QCD predicts the jets well, but at higher energies, the Fermilab team reports in *Physical Review Letters*, there seem to be more of them than there ought to be. This implies that quarks are not point-like, but have a structure of their own, driving a hole through QCD and the standard model.

Obsequies would be pre-mature. The results still have to be confirmed, and the team responsible is not claiming to have found any new physics But if the result is confirmed, what would have to give? Fudging QCD so that it fits the

new observations would be very difficult, but it may be that the QCD calculations predicting the jets are wrong. That would be easier to bear.

Another possibility is that quarks have a 'super-strong' force holding them together as well as the strong force. Yet another would be that quarks are no more fundamental than Rutherford found the atom to be. But at the moment, says Dr. Frank Wilczek of the Institute for Advanced Study at Princeton, "no ready explanation appears compelling". In plainer language, puzzlement is the order of the day.

Astronomers Obtain First Definitive Images of Brown Dwarf

U.S. astronomers say they have obtained the first definitive images of a "brown dwarf", a mysterious celestial object more massive than a planet but too small and cool to shine like a star.

Astronomers from the California Institute of Technology in Pasadena, California, and the Johns Hopkins University in Baltimore, Maryland told reporters that the candidate brown dwarf, called Gliese 229B, is located 18 light years from Earth in the constellation Lepus.

The researchers said that the brown dwarf, discovered with the 152-centimetre reflecting telescope at Palomar Observatory in southern California, is a small companion to the star Gliese 229. The brown dwarf is at least 250,000 times dimmer than the sun, making it the faintest object ever seen orbiting another star.

The initial image of Gliese 229B was backed up by infrared spectroscopic observations made with the 508-centimetre Hale telescope at Palomar and a confirmatory image from the orbiting Hubble Space Telescope.

"This is the first time we have ever observed an object beyond our solar system which possess a spectrum that is astonishingly just like that of gas giant planet", said Shrinivas Kulkarni, a member of the team from Caltech. "It looks like Jupiter, but that's what you'd expect for a brown dwarf."

The observations made with the Hale telescope showed that Gliese 229B has the spectral "fingerprint" of the planet Jupiter—an abundance of methane, a compound that has never before been seen in ordinary stars.

"The methane spectrum proves beyond a shadow of a doubt that this object is way below the mass of a star", said astronomer James Liebert of the University of Arizona.

And yet it is not a planet either according to the researches. They estimated that Gliese 229B to be 20 to 50 times the mass of Jupiter, making it too massive and hot to be classified as a planet, but too small and cool to shine like a star.

Brown dwarfs are a mysterious class of objects that form the same way stars do—condensing out of a cloud of hydrogen gas. However, they do not accumulate enough mass to generate the high temperatures needed to sustain nuclear fusion at their core, which is the mechanism that makes stars shine.

Brown dwarfs, which are dim red objects, shine in the same way that gas giant planets like Jupiter radiate energy, that is, through gravitational contraction.

Researches said that the discovery is an important first step in the search for planetary systems beyond the solar system because it will help astronomers distinguish between massive Jupiter-like planets and brown dwarfs orbiting around other stars.

And for astronomers hunting for brown dwarfs, the detection of methane could mean an end to having to limit their searches to companion stars or dim members of star clusters and instead they can simply screen dim objects for the gas's signature.

Finding brown dwarfs aids astronomers in the search for the so-called missing mass in the universe. The objects visible in the universe do not account for all the mass that must exist there, based on the observed motion of the stars and galaxies. It has been suggested that a good portion of the missing matter exists in the form of brown dwarfs. But, until now, none had been positively identified.

To discover Gliese 229B, the researches used the Mount Palomar telescope with a stellar coronagraph to block out the bright main star, creating an artificial "eclipse" that allowed them to detect any cool, dim companion stars. The coronagraph used an image-sharpening device called adaptive optics to follow the brown dwarf's flickering image.

A group of researches from the University of California and San Francisco State University claimed to have detected the first confirmed brown dwarf earlier this year. The candidate brown dwarf, known as PPL15, was found in the Pleiades cluster of stars, 400 light years away from Earth.

The astronomers identified the brown dwarf by detecting the presence of lithium through the use of the world's largest telescope, the 10-metre Keck instrument of Manua Kea in Hawaii. Lithium, a primordial element present in the formation of celestial objects, is eventually destroyed by the nuclear fires of stars, but continues to exist in brown dwarfs because they are not massive enough to sustain fusion reactions.

While scientists called the finding "tremendously exciting", they said there is the possibility that PPL15 is actually a small, cool star, or a stellar object that burned briefly, but then died out before it could destroy all of its lithium.

COURTESY : *Science Update*

Four New Brown Dwarfs in the Milky Way Detected

At the National Astronomy Meeting in Liverpool, Mike Hawkins of the Royal Observatory in Edinburgh described observations of six brown dwarfs. Four of the stars are within 150 light years of the sun, which makes them local in astronomical terms.

Unlike brown dwarfs that have been identified previously, they are not part of binary systems or clusters, but sit alone and palely loiter among the ordinary stars of the Milky Way.

Brown dwarfs are objects that may be 60 times as big as the planet Jupiter, but only one-fifteenth the mass of the Sun. They are too cool to set off the nuclear reactions that make the Sun and other stars of its type so hot and bright.

Dr. Hawkins and Hugh Jones of Liverpool John Moores University have studied images taken by a British tele-

scope in Australia and analysed in Edinburgh using Cosmos, a computerised system for studying images of the sky. They were looking for objects that appear red, the signature of small, failed stars.

Using the computer, they laid 100 images of the same area of sky on top of one another and the stars that has been invisible on the individual images slowly merged.

The discovery of four brown dwarfs in our own backyard, so to speak, suggests that there may be many more both in our galaxy and in others. If so, they could account for a substantial fraction of the missing mass known to be present in galaxies but currently undetectable.

Cometary Knots Detected

Floating in space, 450 light years away, are tadpole-shaped pods with comet-like heads twice the diameter of our solar system and tails 160 billion km long. And they may just be the first of trillions of such objects in the universe.

The Hubble space telescope has returned pictures of these wraith-like formations and it's on a search for more.

Astronomers call the images 'cometary knots' because their glowing heads and filmy tails superficially resemble comets, or giant tadpoles too, and sperm.

Hubble astronomer, C. Robert O'Dell and graduate student, K. Handron of Rice University in Huston found the knots while exploring the Helix Nebula, a ring of glowing gases in the constellation Aquarius.

They believe they are the result of a dying star's final outbursts, when it ejects shells of gas into space.

"Mr O'Dell expects the gaseous knots, which are each several billion kilometres across, will eventually dissipate and vanish into the cold emptiness of interstellar space", said the Space Telescope Science Institute in announcing the findings.

The most visible of the knots are along the inner edge of the ring, their tails forming a pattern around the star like the spoke on a wheel.

The knots should be history in a few hundred thousand years. As the institute said dust particles inside each gas ball might collide and stick together, ballooning to earth-size over time and icy cold like the planet Pluto.

"These icy worlds would escape the dead star and presumably roam interstellar space forever", according to the institute.

Fresh Explorations of the Red Planet

The red planet Mars probably gives us the best chance of finding anything like that in our solar system, says Dr Stephen Clifford, a geologist at the Lunar and Planetary Institute in Houston, Texas.

The geological history of Mars show that it was once covered with oceans and seething with volcanic activity. New information indicates it could still be damp and warm enough to host primitive micro organisms, at least in fossilised form.

The USA is planning to send two space probes to Mars later this year, thus beginning a round of international exploration of the red planet, reports DPA.

The U.S., European, Russian and Japanese space agencies plan up to 20

unmanned Mars flights in the next decades to search for water and signs of primitive life.

The two probes due for launch this year are precursors of another unmanned mission in 2005 to find out why the planet changed from a watery, warm world like ours to a lifeless, cold desert.

The latter mission includes releasing a six-wheeled "Mars Rover" to collect samples of rocks and soil by a landing probe that will make its own fuel for the return to earth.

For most of the probe's 583-days stay on Mars, the metre-long rover will roam the planet's surface under control from earth-based scientists. It will be equipped with a robot arm to scoop up rocks and soil that will then be carried back to the mother ship for transport back to earth.

While the rover is busy at work, the spacecraft's fuel factory will absorb carbon dioxide from the thin Martian atmosphere and turn it into either oxygen or a mixture of methane and oxygen to be used as fuel for the 205-day return flight.

This process, which has never been attempted before, is expected to reduce the costs of the mission by one-third, according to the magazine aviation weekly and space technology.

Scientists are still working on the best way to produce the estimated one ton of liquid fuel needed for the return journey of the probe and its two kilos of Martian rocks.

The race to Mars gets underway in November with the launch of the Mars global surveyor, which will circle the planet for nearly two years, using a laser altimeter to map its terrain.

A month later the Mars pathfinder will carry a small robot rover which will act as a test vehicle for the 2005 mission.

Vitamin E Reduces Chance of Heart Attack

A team of Cambridge University medical scientists led by Morris Brown and Malcom Mitchinson has been studying the effect of vitamin E supplements on the health of 2,000 patients with heart disease. Their findings, published in the Lancet, show that vitamin E supplements are more effective than aspirin or cholesterol lowering drugs in preventing heart disease. High doses of vitamin E can reduce the risk of a coronary by 75% in patients with heart disease.

Many fatty foods, including butter, peanuts, sunflower and soya oil are rich in vitamin E but are not suitable for cardiac patients for their high calorific value. However, a patient with heart disease is allowed to take olives, fish, mackeral like Tuna, herrings and salmon, all foods with a naturally high vitamin E content. The diet would be even richer if salmon was accompanied by asparagus, the vegetable richest in vitamin E.

Prof. Brown's and Dr. Mitchinsons' patients were given between 400 and 800 IUs daily. When taking vitamin E at these doses, the risk of a heart attack was no greater for one of their cardiac patients than it would be for people who were not suffering from any detectable heart complaint. The daily intake of vitamin E in a well-balanced diet is between 10.4 and 13.4 international units.

A vitamin-enriched diet has been

scorned by more traditional doctors eversince vitamins were discovered. The accepted teaching is that supplements are unnecessary if someone's diet is well-balanced and, in the case of some vitamins, can be dangerous.

No vitamin has been more controversial than vitamin E. Its value has been understood only since study of the ability of the anti-oxidant vitamins, of which E is one, to prevent atherosclerosis (furring of the arteries).

Man to Man Transmission of Buffalo Pox

Indian scientists have observed man to man transmission of Buffalo Pox Virus (BPV) for the first time in this country.

Scientists at the National Institute of Virology in Pune who investigated a recent outbreak of Buffalo pox in Beed district of Maharashtra found five human cases — all infants who had never gone anywhere near buffaloes. They obviously picked up the virus from their parents.

During the same period, in another district of Maharashtra, 58 people came down with pox disease, of whom, one was a 12-month-old child and another a pregnant woman who picked up the virus not from the animal but from her husband, a milker.

The evidences indicated that there is a situation in this country where BPV infection appears to be spreading from one person to another.

A serological survey by the team has revealed the presence of antibodies against BPV not only in affected humans, but also in 70% of their contacts and 17% of individuals who had no contact either with buffaloes or infected humans.

BPV is a relatively harmless cousin of the smallpox virus that was eradicated from the world 15 years ago.

The pox disease in buffaloes and cattle has been known in the Indo-Pak subcontinent since 1934. The disease causes ulcers in the teats and udder of the animals and renders them unproductive.

It was also well known that humans coming in close contact with infected animals also develop the pox disease which produces mild fever, pock lesions in hands and, occasionally, swelling of the lymph nodes.

But till now, the disease had been spreading only from infected animals to humans and no man-to-man transmission had ever been reported. This situation is now changing and that is why medical scientists are worried.

There is an indication of "subclinical infections", which means that the general population is getting exposed to BPV. According to Dr. K. Banerjee, Director, NIV, Pune, it is a bad omen because "the virus, after repeated passage through humans, can acquire virulence".

In the recent outbreak in Beed, NIV scientists found pox victims suffering from usually high fever of 104 degrees and having several pock lesions instead of just one or two seen in the past.

Dr. Banerjee said that smallpox vaccine apparently gave no protection against BPV as the buffalo pox disease struck both vaccinated and unvaccinated individuals.

The scientists say that there is nothing alarming about what they have observed in recent buffalo pox outbreaks in Maharashtra. But they caution that the virus needs to be carefully watched as it

could potentially become a public health problem.

The World Health Organization which played a key role in eradication of small-pox is quite concerned and its regional office in New Delhi is gathering information.

Indian Scientist Isolates DNA of Dinosaurs

Dr. H.M. Saxena, Senior Associate Professor of Veterinary Immunology of the Punjab Agricultural University, Ludhiana and his brother, Jagmohan Saxena, a film maker of wood fossils have discovered an area containing many new sites with huge deposits of about 100 to 300 million years old animal fossils in the desserts of Rajasthan.

Dr. H.M. Saxena reported at IVRI in Bangalore that the fossils of aquatic reptiles and dinosaurs are several hundred million years old, dating back to the cretaceous, Jurassic, Triassic and Permian ages.

The fossils had been identified as being that of dinosaurs and their ancestors and primitive reptiles of a vast variety of genera and species. Such a large site with huge fossil deposits had never been discovered in South Asia, he said.

The specimens include petrified partial skeletons of a baby Sauropod dinosaur and two vertical neck turtles, numerous bones, and eggs and pieces of petrified skin.

These specimens, he said, are from the cretaceous hoofed horned and armored ornithopod dinosaurs, Jurassic Sauropod dinosaurs and Triassic and Permian euryapsid reptiles.

For further characterization of the samples he had collected, he said he would get in touch with the American Museum of Natural History in New York, which has the expertise in such matters and the finest collection of dinosaurs and ancient reptiles.

Dr. Saxena had recently been successful in isolating the genonmic DNA of two dinosaurs, one from dried blood from the petrified skin of a dinosaur and the other from the bone marrow of a shoulder bone of a horned dinosaur.

He said he had also amplified the DNA from a sample more than a million fold, using a technique called polymerase chain reaction, with the help of molecular biologists at the Indian Institute of Veterinary Research.

So far, only half a dozen laboratories around the world have been successful in isolating the DNA of dinosaurs.

A Simpler Method of Dialysis

Thousands of people suffering from kidney failure every year perhaps will be able to avail in the near future a less cumbersome and low-cost option. At present, most of the patients have to rely on dialysis. The process of dialysis essentially involves removal of wastes from the blood with the help of semi-permeable membrane. This is done by drawing out blood and pumping it through the membrane with the help of a machine. The process is not only expensive but is not available to all patients in India due to limited number of machines at present.

Moreover in this technique, the patient has to undergo dialysis two to three times in a week for which he has to be hospitalised.

A new technique of dialysis is now becoming popular. This is known as Continuous Ambulatory Peritoneal Dialysis (CAPD). The basic difference between CAPD and traditional method is that in the latter method, the peritoneal membrane forms a cavity in the abdomen which is used to filter the blood. The patient has just to connect the fluid bag to a tube. This tube is implanted in the abdomen by a surgical operation. Once the tube is connected the blood passes through the membrane and gets filtered. The advantage of this method is that the patient need not be hospitalised again and again.

Gene Therapy Holds Promise for Future

Although there is no clear-cut evidence that even one patient has been cured by gene therapy, even the harshest critics of today's studies do not doubt that gene therapy will one day transform the practice of medicine.

In 1990 scientists made medical history by transferring genes into a human being for a purely therapeutic purpose. Since then over 100 studies involving 597 patients have been conducted.

While none of these studies have shown human gene therapy to be completely effective, a few have provided results that researches believe hold great promise for the future.

One of the most successful cases of gene therapy involved two seriously ill children suffering from a rare genetic disorder called adenosine deaminase deficiency. They received an infusion of genetically altered genes in 1990 and are now, six years later, leading active normal lives without fear of becoming gravely ill from a minor infection.

According to a research paper published in a recent issue of the journal *Science*, both girls have developed stronger immune systems and still have white blood cells bearing copies of the replacement gene that was almost non-existent prior to their treatment.

But it remains unclear how much of the girls' improvement can be attributed to their new genes and how much is due to a drug they have been taking called PEG-ADA. Also researchers point out, the girls were chosen because their disease was deemed relatively easy to cure with the crude genetic material available.

However, these results indicate that cells bearing the new genes survived and that the disabled virus used to transfer the replacement gene into the cell, called a viral vector, will not cause adverse short-term health effects. Both issues are considered critical in establishing the safety and efficacy of gene therapy.

While withdrawing the PEG ADA would be the next step in evaluating the outcome of gene therapy in this study, the scientists say they are unsure about the effect this would have on the girls.

"As a scientist I would very much like to know the answer to this question", says Dr. R. Michael Blaese, who headed the study. "But as their pediatrician I'm not yet prepared to take the step of completely stopping their enzyme treatment and possibly putting them at risk until we know even more about the extent and duration of their improved immune function".

In another study, researchers at the

National Institute of Aging have developed a process that uses a virus to transport DNA fragments to chemically deficient sites in the brains of laboratory animals. The process, while as yet only involving animals, has the potential to be a first step towards reversing deficiencies in the brains of humans with various age-related neurological diseases, such as Huntington's disease and Parkinson's disease.

According to researchers, gene therapy represent the ultimate medical cure in attempting to eradicate a disease by healing the gene itself.

The role of gene therapy, simply stated, is to provide the body with healthy genes that will fulfill the role of defective genes. Gene therapy entails replacing a defective gene in the nucleus of a cell with a functioning gene and coaxing that new gene to manufacture its proteins product.

Most human diseases are the result of excessive or flawed protein production. Gene therapy might either replace a protein that is missing due to an inherited disorder or it might bolster a cell's ability to synthesize immune system proteins, enabling it, for example, to better fight cancer.

Dr. W. French Anderson, a pioneering advocate of gene therapy says, "Gene therapy is actually a sophisticated drug delivery system". He explains that the patient's own cells can be engineered to pump out anything that is now given by injection.

Although researchers have developed several methods for transporting genetic material, the most effective technique employs modified viruses as carriers. Viruses are useful because they are naturally able to penetrate cells and thereby insert the genetic material they contain into their new host.

Genes can also be delivered by a jolt of electricity or chemicals which open transient holes in cell membranes, through which a therapeutic gene can be inserted.

Physicians can apply gene therapy either by inserting a healthy copy of a gene into a patient's cell in order to compensate for a defective gene or by introducing a purposely altered gene in order to give a cell a new property.

The delivery of genes to cells is a major hurdle facing gene therapy. Researches say that the low rate of gene transfer has made it difficult to know whether the genes being delivered are actually doing any good, or whether they are even hitting the target cells.

In some cases the virus vector has itself caused problems, such as inflammation in some patients. For example, a virus containing a gene that was intended to treat brain cancer gave one patient meningitis by infecting the brain lining.

Another disappointing experiment involved inserting a genetically engineered version of the common cold virus into a normal gene. The virus was used to infect the tissue lining the noses of 12 cystic fibrosis patients. The researchers found evidence that in five of the patients who had received the highest dose of the virus, the gene was successfully transferred to small patches of nasal lining. However the patches that incorporated the new gene and began to make the missing protein were so small that they had no effect upon the disease.

Several of the patients who had re-

ceived the higher doses were also experiencing side affects, another problem associated with gene therapy.

In yet another experiment, normal but immature muscle cells, called myoblasts, were repeatedly injected into the arm muscles of a dozen boys afflicted with muscular dystrophy. Each boy received fake injections in their other arm. A year and half later the researchers were unable to measure any difference in strength between the treated arm and the sham-injected arm.

However, laboratory tests showed that the muscle fibers from one boy were producing the missing protein at relatively high levels, indicating that the injected cells were functioning.

An advisory panel of scientists convening recently at the National Institute of Health (NIH) warned that the efficacy of gene therapy has been exaggerated, and urged scientists and journalists to inform the public about not only the promise of gene therapy but also its limitations.

"Despite the growing support for gene therapy, it must be acknowledged that it is at a very early stage of development", said Dr. Harold Varmus, director of NIH. He adds that there is little or no evidence of therapeutic benefit in patients.

The advisory panel, although it did not recommend an end to tests of gene therapy in humans, strongly urged that more emphasis be put on basic research that would precede testing in people. The panel added that, because clinical experience is still so limited, possible long-term adverse effects from gene transfer therapy cannot be excluded.

For the next decade, gene delivery is most likely to be performed only on somatic cells that affect only the patient undergoing treatment and are incapable of passing man-made genetic alterations to a patient's offspring.

In theory, gene therapy could also be applied to the reproductive, or germ cells. As modification of these cells would alter the genetic makeup of subsequent generations of the original patient, few scientists would choose to open the Pandora's box of ethical concerns that would ensue.

"The idea that gene therapy will be available to a sizable number of people any time in the near future is pie in the sky", says Tori Ziegler, a geneticist at the University of California at San Francisco. The reason, she explains, is that most of the 4,000 or so genetic disorders involve more than one gene and are not very well understood.

However, the Human Genome Project, an international effort launched in 1989 to understand the language of human genetics, has and will continue to unleash a torrent of information over the next decade. A genome is the sum total of genetic material (DNA) in the chromosomes of a specific organism.

"The human genome is the complete set of instructions for making a human being", explains biochemist Robert Sinsheimer of the University of California at Santa Barbara.

One of the benefits of the Human Genome Project is the identification of more and more of the defective genes responsible for the thousands of known inherited diseases. New avenues are being opened not only for the science of gene therapy but for the pharmaceutical industry as well.

But finding a gene is not a simple task. When asked how difficult it was to locate the cystic fibrosis gene, for example, University of Michigan geneticist Francis Collins described it as "the equivalent of knowing a light bulb is out and having to check every house in the United States to find it".

Although virtually all experts agree that we are in the midst of a genetic revolution, there is considerably less consensus on when gene therapy's tremendous potential will be realized.

Even Anderson, gene therapy's biggest booster, says, "We must be careful not to oversell gene therapy to a hopeful public".

COURTESY : *Science Update*

Scientists Say Warming Causes Antarctic Ice Shelves to Melt

Scientists report that atmospheric warming caused the Larsen Ice Shelf on the east coast of the Antarctic Peninsula to disintegrate last year and several other ice shelves to shrink dramatically over the last 50 years.

Researchers reported in a recent issue of the journal *Science* that detailed satellite images show that the break up of the main part of the 800-square-kilometre Larsen Ice Shelf occurred in less than a week—a very short period of time in a region where responses to climate changes can take decades or centuries.

The disintegration of the Larsen Shelf follows the gradual breakup of the Wordie Ice Shelf, which has been retreating on the west side of the Antarctic Peninsula since 1966. Three other ice shelves attached to the peninsula have also been shrinking. The peninsula juts out of the Antarctic continent toward South America.

Ice shelves are floating bodies of ice that are fed by glaciers and snowfall. About half of Antarctica is bordered by ice shelves ranging in size from a few square kilometres to 500,000 square kilometres, as in the case of the Filcher-Ronne and Ross ice shelves, which flank the vast West Antarctic Ice Sheet.

Glaciologists with the British Antarctic Survey based in Cambridge, England, report in a recent issue of the journal *Nature* that one of the possible consequences of continued warming in the Antarctic is a rise in worldwide sea level caused by the melting and disintegration of inland ice sheets such as the West Antarctic sheet.

While the disintegration of the Larsen Ice shelf and the shrinking of other Antarctic shelves have no effect on sea level, because the ice involved is already floating, the shrinkage of the inland ice sheets that are grounded on a bed below sea level would add to the ocean's volume.

Some scientists believe that a large enough warming could eventually melt the giant Filcher-Ronne and Ross ice shelves, which are thought to be critical to the stability of the West Antarctic sheet. The loss of the shelves would allow West Antarctica's giant inland glaciers and ice streams to flow into the ocean where they would melt and cause a catastrophic rise in global sea level.

A United Nations panel of scientists has predicted that continued emission of heat-trapping gases like carbon dioxide, produced by the burning of coal,

petroleum and wood, could increase the average global temperature by about 2.5 degrees Celsius by 2100. The panel said this could result in a melting of glaciers and thermal expansion of the ocean that would cause average global sea level to rise by a best estimate of 50 centimetres.

But British scientist David Vaughan, a co-author of the report in *Nature*, said recent evidence indicates that the West Antarctic Ice Sheet may be more stable than previously thought and that the new evidence of ice-shelf disintegration may not presage the destruction of the West Antarctic sheet.

According to Vaughan, it would be necessary for the average global temperature to rise an additional 10 degrees Celsius for the Filcher-Ronne and Ross shelves to melt. A rise in temperature that high would create a climate as warm as that of the Cretaceous period 65 million years ago— a period when polar ice melted completely.

Vaughan also points out that one effect of global warming in Antarctica might be a thickening of some ice sheets and shelves. According to this theory, global warming is likely to result in heavier precipitation, which would produce a heavier accumulation of snow in Antarctica that does not melt, but rather compresses under its own weight into more ice.

The British scientists also report that Antarctica is not warming uniformly. The climate on the Antarctic Peninsula where the ice shelves are retreating has warmed by about 2.5 degrees Celsius in the last 50 years, but the warming has been less than 1 degree Celsius for Antarctica as a whole.

Researchers reporting in the journal *Science* article conclude that the complete disintegration of the Larsen Ice Shelf raises a question about the origin of such shelves: Can these shelves re-form under climatic conditions similar to today's or were they able to form only under the colder conditions of the last glacial period?

If the ice shelves can re-form in a few centuries, perhaps with a slight drop in temperature, then their disintegration may signal a small perturbation in a few-hundred-year climate cycle. But if the ice shelves cannot re-form, then they might be signalling an event that is unique for this period of geologic time.

Courtesy . *Science Update*

Early Detection of Breast Cancer Risk

Researchers report that they have moved a step closer to developing a diagnostic test for identifying at an early stage those women most at risk for breast and ovarian cancer.

U.S. and British researchers said they have identified specific mutations to the so-called BRCAI gene tumor suppressor gene that when altered is known to increase susceptibility to breast and ovarian cancer.

Researchers estimate that women who have inherited harmful BRCAI mutations have an 86 per cent lifetime risk of developing breast cancer. The gene itself was discovered in September 1994.

Research teams at nine laboratories in the United States and Britain tested for BRCAI mutation in DNA samples from over 1,000 patients with breast or

ovarian cancer and found 38 distinct mutations related to the diseases, with three appearing to be relatively common.

Researcher Mark Skolnick of the University of Utah School of Medicine in Salt Lake City said that the BRCAI gene may have as many as 200 mutations that lead to cancer.

"Once we find these mutations, we'll have to examine them to determine which ones cause disease and which ones are neutral", he said. "Then we'll have better idea about which mutations may be responsible for breast cancer, ovarian cancer or both".

Researchers said that identifying the mutations represents the first step in the development of a diagnostic test that would help doctors make decisions about early treatment or about procedures that could prevent the disease.

The researchers also found that many of the mutations result in a truncated BRCAI protein. This may lead to development of a cancer screening test because by knowing what kind of abnormality a mutation will cause, doctors may then test for that abnormality rather than for the whole gene.

Another research team studying the so-called ALL1 gene, which is linked to development of certain acute leukemias, has found an unusual fusion of identical parts of the gene in some patients. Dr. Steven Schichman of Thomas Jefferson University in Philadelphia, Pennsylvania, said that just how this genetic defect occurs or how it causes leukemia is unknown, but that the defect is present in patients who have a particularly poor prognosis and high risk of relapse.

Schichman said the discovery of the gene abnormality may allow researchers to develop a test to identify patients with the genetic flaw and new approaches to treat such patients.

"Whenever you identify a gene defect, you have a potential target for therapy in the future", he said. "Prior to identifying the ALL1 self-fusion defect, we didn't know how these leukemias occured on a genetic basis, and now we do".

Still another team of researchers at the National Cancer Institute have identified a gene that may lead to early diagnosis and treatment of kidney cancer.

The scientists found the gene for von Hippel-Lindau disease, or VHL, an inherited condition linked to kidney cancer. The VHL gene is also involved in non-hereditary clear cell reneal carcinoma, the most common form of kidney cancer.

Renal carcinoma is responsible for over 11,000 deaths in the United States each year, and its incidence worldwide has been increasing at an annual rate of 2 per cent.

Kidney disease is often not found until it has spread, at which stage most patients die within two years. However, if kidney cancer can be diagnosed and treated while the tumor is contained within the organ, the cure rate is about 95 per cent.

COURTESY : *Science Update*

Warmer Climate Slowing Growth of Northern Forests

Scientists report that several decades of warmer temperatures in the northern

latitudes could be slowing the growth of trees throughout the great belt of boreal forests that stretches across Canada, Alaska and Siberia.

A four-year study of annual growth rings in trees growing in northern and central Alaska showed that recent decades of warming, instead of encouraging abundant forest growth as might be expected, may be slowing growth by promoting moisture loss in trees and increasing tree-attacking insects and disease.

Climate models have predicted that global warming would have a pronounced effect in higher northern latitudes, leading to speculation that the northern forests would thrive under warmer conditions, even to the extent that the northern edge of the forests would be pushed farther into the Arctic.

But scientists at Columbia University's Lamont-Doherty Earth Observatory concluded in their report— published in the journal *Global Biogeochemical Cycles*— that the recent increase in temperatures combined with drier years may be unduly stressing the trees, "raising the potential for some forest changes in Alaskan and other boreal forests... within decades".

Because of dryness, some areas might not regenerate tree cover and would become grasslands if deforested by fire", the report added.

The tree-ring data collected by the scientists confirmed the high-latitude warming over the last century seen in weather station records of air temperatures and in bore-hole measurements, which detect traces of past surface temperatures deep underground. These measurements showed that the far-northern climate has warmed some 2 degrees Celsius since the 1880s, much more than the rest of world.

According in Gordon Jacoby, a dendrochronologist at Lamont-Doherty, the tree-ring record from some of the oldest Alaskan trees indicates that temperatures became unusually warmer starting in the 1940s—warmer than at any other time in the last 300 years.

Jacoby said that this warming trend, which actually began early in the century, initially increased tree growth in the 1930s and 1940s by lengthening the growing season. However, despite continuing warm temperatures, the growth increase has declined since the 1970s.

After a cooler interval from the 1950s to the early 1970s, annual temperatures have been returning to the peak 1940s level, but the trees are not responding to the renewed warmth. Instead, the trees show evidence since the mid-1970s of suffering from what Jacoby called "moisture stress".

If there's enough moisture, warmer temperatures help boreal trees grow better, Jacoby said. But if it's too warm for too long, evaporation becomes a major factor.

Warmer temperatures increase evaporation of water from the leaves and needles of trees, increasing the tree's demand for water. Even with normal precipitation, continued warm temperatures can lead to relatively drier conditions at the sites sampled, diminishing the water in the soil that is available to the trees and thus slowing growth.

"I think it's been warm enough long enough at some of these sites that the permafrost layers may have been melted

a little bit deeper and the water seeped away, so that it was just a gradual drying out after decades of warmth", Jacoby said.

"Recorded temperature information shows warming taking place across Siberia, Scandinavia and northern North America", he added. "So if moisture stress can have an effect on trees in Alaska, it's reasonable to think it can also effect trees in those other places. May be some people, following the release of our data, will test for the same effects in other countries".

In addition, warmer temperatures may be beneficial for insects and diseases that attack trees.

"There is...evidence of increasing insect damage and disease, possibly related to warmer temperatures", the researchers report. They added that "severe outbreaks" of break beetles have devastated several million hectares of forest in southern Alaska.

To obtain the temperature record and determine tree growth rates over past centuries, the scientists took core samples from white spruce in five sites in northern and central Alaska. White spruce was selected because of its sensitivity to climatic change and its widespread distribution across northern North America.

The scientists sampled the trees by drilling out a slender plug of wood, five millimetres in diameter, that transacted all the annual rings. In general, wider rings correspond to warmer times and narrow rings to colder periods. Using samples from trees hundreds of years old, they reconstructed a record of annual temperatures back to the 1680s. The record is one of the few sources of information about the Alaskan climate before the modern era of meteorological recording.

The research team had to charter small planes and travel by foot or boat to samples trees at remote locations and high elevations, where the trees would be near the limit of their survival and thus very sensitive to climate change.

Tropical Forest Drugs

Economists have been trying to estimate the value of yet undiscovered disease-fighting-drugs in the forests of developing countries and two recent projections are very little to several thousand million dollars. Some of the first estimates several years ago went as high as $900,000 million.

Such a large amount suggested that developing countries with ecological systems rich in a diversity of plant and animal life could earn a great deal of money by preserving such habitats, which is precisely what environmentalists have been advocating.

Developing countries would get their revenues from "licensing" pharmaceutical companies in the developed world to collect samples of plants and soil microorganisms. These multinational companies would then finance the research into extracting drugs from the plants and pay royalties to the developing countries for commercially successful products.

There have been too few contracts so far for "biodiversity prospecting" for economists to estimate how much developing countries could eventually earn. Instead, they have concentrated on estimating revenues for the pharmaceuticals.

Two of the most recent estimates were presented at the World Bank's third annual conference on the environment on October 4, 5 and 6.

Robert Mendelsohn, an environmental economist at Yale University, told the panel that a study with a colleague indicated that pharmaceutical companies could hope to earn $3,000 to $4,000 million from developing drugs from all of the tropical plants now in existence.

Mendelsohn said his estimate is more conservative than previous ones because it takes into account the high cost of the research and development that leads to a successful drug.

The study uses work by ecologists to estimate that 125,000 flowering plant species, half of all those in the world, live in tropical forests. Six different extracts could be made from each plant and filtered through 500 tests that pharmaceutical companies have devised to identify useful compounds.

About one in a million of these tests identifies a useful compound, which calculates out to 375 potentially valuable drugs existing in tropical forests. Mendelsohn said of this total, 47 have already been discovered.

A U.S. pharmaceutical company typically spends about $ 155 million over 9 to 12 years to develop and get government approval to market a drug.

A company can expect to earn about $150 million over the 10 years in which it has a patent to exclusively produce and sell the new drug. Earnings could remain high but do decline in the following 10 years.

"The potential value of undiscovered drugs is an additional incentive to conserve species-rich forests throughout the world', Mendelsohn says in his study.

In order to provide incentives to local people to conserve their tropical habitats, he said it was important to establish property rights there or at least the right to a part of the income the government may earn from permitting biodiversity prospecting.

But David Simpson, an economist at Resources for the Future, a Washington research organization, said at a panel discussion that in a study with two colleagues they found that there was very little value in bioprospecting. The reasons include: the number of species in tropical areas are numbered in the millions, pharmaceutical companies often use synthetic chemicals in making their drugs, research and development costs for the companies are high and there is very little probability that a particular species would yield a valuable drug.

Pharmaceutical companies would be making a great many more deals with developing countries if they believed bioprospecting could be profitable, Simpson said.

"Our point is, rather, that if the international community values biological diversity, it should be actively seeking other alternatives for financing its conservation", the authors said in their study.

COURTESY : *Science Update*

Asian Elephant Survival is Threatened

Although the survival of the African elephant has been a major cause of governments and conservation organizations for several years, a new study argues

that the Asian elephant is far fewer in number and closer to extinction.

About 35,000 to 50,000 elephants are scattered in small herds, generally, in parts of the Indian sub-continent, South-east Asia and south-western China, according to a report by the World Wide Fund for Nature.

This is one-tenth the estimated number of African elephants, the report said.

"The Asian elephant has been overshadowed by its better-known African cousin even though it is more endangered", Thomas Mathew, director of the World Wildlife Fund (as the World Wide Fund is known in Canada and the United States) South and East Asian Programs, said in an interview.

Only about 10 of the Asian herds have more than 1,000 individuals, which some scientists believe is the minimum required to maintain a healthy group. Although the African elephant is no longer found in areas it used to inhabit, the shrinkage of the separate Asian species has been particularly severe—historic accounts indicate it was found from Iraq and Syria across to the Yellow River in China.

"The Asian elephant...is being squeezed out of its forest home by unchecked logging, agricultural clearance and ill-planned development schemes", the report said.

The rapid growth of human populations in Asia has led to people and elephants competing for forest land. Hungry elephants have raided farm plots and killed people who got in their way. In India alone, about 300 people have been killed.

But ivory poaching still is a big problem in some areas, particularly southern India, Mathew said.

Trade in ivory, hides and other parts of the Asian as well as the African elephant is banned under an international treaty to which most countries of the world belong. The ban has largely but not completely halted the poaching for ivory, which is then shipped to East Asia, carved and collected.

The report calls on developed countries to increase their funding of elephant conservation programs. The Asian Elephant Conservation Group, composed of most of the countries that have herds, has had a small but effective program of sharing data, convening experts on particular problems and local education, Mathew said.

Conservationists believe that some land would have to be reconverted into forest-habitat to reverse the decline in elephant herds, Mathew said. No one has put together an estimate of the cost of a total preservation program, he said.

But dwindling herds in Vietnam demand emergency action, he said, which alone would cost $ 500,000 to end poaching, compensate villagers for crop loses and prevent further destruction of range forests.

The World Wide Fund has a number of small conservation programs in the range states, which include Malaysia, China, India, Thailand, Indonesia, Nepal, Bhutan, Vietnam, Laos and Burma.

COURTESY : *Science Update*

New Class of Drugs Shows Promise in Fight Against AIDS

Scientists have reported exciting results using a powerful new class of drugs

that can suppress the growth of the AIDS virus and, in some cases, prolong the life of patients suffering with the deadly disease.

The researchers said being able to suppress the growth of the human immunodeficiency virus (HIV) that causes AIDS, while it does not constitute a cure for the disease, raises the possibility of halting the relentless destruction of the body's immune system. The new class of anti-AIDS drugs is called protease inhibitors.

"We are at a pivotal time in the treatment of HIV disease and AIDS where for the first time we may be close to achieving almost total suppression of AIDS virus reproduction in most patients", said Dr. Emilio Emini, a researcher at Merck Research Laboratories.

Speaking at the recent Conference on Retroviruses and Opportunistic Infections, researchers reported that in one study the drug indinavir—a protease inhibitor developed by Merck—was able to eliminate all measurable traces of HIV in 24 to 26 patients for at least six months when combined with two licensed AIDS drugs, AZT and 3TC.

In eight patients who received only the combination of AZT and 3TC for 24 weeks, the virus continued to be detected in high amounts. The study was led by researchers at New York University.

According to Emini, one patient receiving indinavir alone, as part of a different study, has maintained an undetectable level of HIV and has remained healthy for two years.

Researchers have also reported exciting results from a study involving another protease inhibitor called ritonavir. The study showed that patients with advanced AIDS taking ritonavir over a six months period had a 40 per cent less chance of dying than similar patients taking dummy pills.

The study, overseen by doctors at the University of Ottawa, involved over, 1,000 patients at 67 hospitals in the United States, Canada, Europe and Australia.

Abbott Laboratories, which makes ritonavir, has applied to the U.S. Food and Drug Administration (FDA) for approval to sell the drug.

The FDA approved the marketing of the first protease inhibitor, saquinavir, last year. However, experts believe that indinavir and ritonavir are much more powerful drugs.

Protease inhibitors, which prevent the maturation of newly produced HIV in the body, act on a different part of the HIV life cycle than drugs like AZT, which attack an enzyme known as reverse transcriptase.

Protease inhibitors work by reducing "viral load", which is the amount of microscopic AIDS virus circulating in an infected person's bloodstream. Viral load is increasingly being used by doctors to predict an HIV-infected person's future health.

Many researchers believe that lowering the amount of virus in the bloodstream helps patients by making them less likely to develop deadly AIDS-related infections.

A major unanswered question in the latest studies is whether any drug or combination of drugs can suppress viral load for years or ideally for an indefinite period of time. Also important is the question of when to begin treatment of a viral infection that, on average, can

exist in a patient for 10 years before causing serious illness.

Lowered Risk of Death

Late last year, another group of researchers at the National Institute of Allergy and Infectious Diseases (NIAID) reported that treating AIDS patients with a combination of drug therapies could not only lower their risk of developing full-blown AIDS but, in certain patients, could reduce the risk of death.

Their study showed that experimental drug therapies were successful in preventing one of the most serious consequences of infection with the AIDS virus—a significant decline in the level of CD4 T cells. These are the body's critical immune system cells targeted by the AIDS virus.

These trials built upon previous studies that suggested antiretroviral therapy could clinically benefit patients with intermediate-stage AIDS infection —those with 200 to 500 CD4 T cells per cubic millimetre of blood.

A healthy individual who is not infected with HIV usually has a CD4 T cell count of 800 to 1,200.

The drug therapies used in the study also helped prevent some asymptomatic patients from developing fatal AIDS symptoms, such as Kaposi's sarcoma, a cancer common to AIDS patients.

"Significantly, the current study has provided the first conclusive evidence that antiretroviral therapy can reduce the risk of death in asymptomatic people", said Anthony Fauci, director of NIAID.

"Other ongoing clinical trials with the medications in this study, as well as newer antiretroviral agents, promise took help further define the optimal care of all HIV-infected patients," he added.

The latest drug trial found that the drug didanosine used alone, a combination of didanosine plus AZT (zidovudine), and a combination of the drug zalcitabine and AZT were each superior to using the well-known drug AZT alone in preventing one or more serious consequences of HIV infection, including a significant decline in CD4 T cells.

The drugs used in the study—didanosine, zalcitabine and AZT—are all so-called nucleoside analogues that act as inhibitors of reverse transcriptase, an enzyme used by the AIDS virus to replicate.

The trial including a total of 2,467 volunteers with intermediate-stage HIV infection. The volunteers, most of whom had no HIV-related symptoms at the start of the study, were observed for 143 weeks.

Immune System Chemicals

Researchers have also identified natural substances in human cells that appear to slow the progression of AIDS and which may be opened new avenues for treating the deadly disease.

They report that they have isolated several molecules secreted by a class of infection-fighting cells known as CD8s. These immune-system cells are thought to play a critical role in controlling the HIV during early stages of infection.

"We identified this family (of molecules) and found that they are very powerful," said Dr. Robert Gallo, the co-discoverer of HIV and director of the new Institute of Human Virology at the University of Maryland.

"There is something happening

here," said Fauci. "There is no question that this is door-opening time."

The discovery was made by a team headed by Gallo and Paolo Lusso of the San Raffaele Scientific Institute in Milan, Italy. The research was conducted at the National Cancer Institute Laboratory in Bethesda, Maryland.

AIDS researchers around the world have been trying to identify the natural HIV-fighting chemicals since 1989 when researchers at the University of California at San Francisco found that the body's CD8 immune system cells produced molecules that appeared to suppress the ability of HIV to copy itself.

Gallo and his team isolated three such molecules—called RANTES, MIPI-alpha and MIPI-beta—that they believe work in concert to suppress HIV replication. The researchers found during testing that the molecules shut down several different strains of HIV reproduction as well as reproduction of the simian immunodeficiency virus, or SIV, a virus that causes AIDS in monkeys.

All three molecules are known as chemokines—secreted proteins involved in the body's wound-healing process.

Immunologist Sergio Romagnani of the University of Florence called the findings very convincing. "It provides direct evidence that CD8 suppression of HIV is mediated by these chemokines", he said.

In another study published in the British journal *Nature*, a team at the Paul Ehrlich Institute in Langen, Germany, led by Reinhard Kurth, reported the discovery of a different—and apparently less powerful—HIV suppressing factor.

Fauci, after reviewing both studies, said he found the Gallo group's results especially convincing because "Gallo is getting really impressive suppression at low concentrations (of chemokines), and in the Kurth paper the concentrations are much higher".

Gallo said that while scientists do not yet know exactly how chemokines suppress HIV, they may still learn how HIV causes disease by studying their mechanism of action.

Gallo said that if the chemokines prove to be non-toxic in animal tests now underway, then they could possibly be used to control HIV for long periods of time in infected patients. The ultimate goal is to begin human clinical trials at Gallo's new institute and at the San Rafaele Institute in Milan.

One cautionary note is that prior research which CD8 cells found that their level HIV-suppressing activity appeared to decline as HIV infected patients progressed to full-blown AIDS. Gallo said, however that it may be possible to boost the body's production of HIV-suppressing chemicals.

Marc Girard of the Pasteur Institute in Paris, a leader of the French AIDS vaccine effort, said that while it is too early to tell whether the chemokines will have practical applications, he is optimistic.

"You open a new window in the wall, and then you have to look through the window to see what you can see", he said. "There's a whole new landscape out there."

Increasing Threat for Young Adults

Meanwhile, a recent study reports that new cases of AIDS are rising rapidly among young adults in the United

States and peaking as they reach their late 20s and early 30s.

They study, released by the U.S. National Cancer Institute, says that while the rate of new AIDS cases among people born before 1960 appears to be reaching a plateau, the rate among individuals born in 1960 or later continues to escalate.

U.S. Secretary of Health and Human Services Donna Shalala said the study raises a "cause for alarm" about the young adult population.

"What we have is a generation in jeopardy, and it is up to us to take action now to reverse these tragic trends before a new generation of leadership for this country begins to be wiped out by the AIDS epidemic," she said.

According to the study, the number of AIDS cases among white men born in 1960 or later rose from 200 in December 1987 to nearly 600 in December 1992. Similar increases were found among African-American and Hispanic men, although the actual number of cases was not as high.

The increase in AIDS cases among women born in 1960 or later was highest among African Americans, escalating from about 25 cases in December 1987 to 150 cases in December 1992.

Previous studies by the U.S. Centres for Disease Control and Prevention (CDC) show the AIDS epidemic taking a particularly heavy toll on young Americans. The CDC reported that in 1993 AIDS became the leading cause of death among Americans between the ages of 25 and 44, and between 1993 and 1994 the number of AIDS-related deaths in that age group rose 8 per cent.

The impact of AIDS on minorities has been particularly heavy. In the 25 to 44 age group, AIDS caused on average one in every three deaths among African-American men and one in five deaths among African-American women. With the long and variable lag time between infection with the AIDS virus and death—a period that could last 10 years or more—many of the young adults in these groups were likely infected in their late teens.

A new public information campaign launched by the Department of Health and Human Services is designed to reach adults between the ages of 18 and 25 with a message that calls for abstinence, prevention and responsibility.

A series of television and radio public service announcements will show young adults talking candidly about their lives and modeling protective behaviours and skills, including abstinence from sex, communication with sexual partners and parents about AIDS, and the correct use of condoms for those choosing to have sexual intercourse.

According to Shalala, a similar campaign launched two years ago offering young adults accurate information on how to protect themselves from AIDS is beginning to work.

"We have seen signs of greater understanding of and use of condoms and we have seen promising signs of a greater degree of sexual abstinence in young people", she said. Shalala added that there has also been a growing movement towards what is called "secondary virginity"— referring to those who began to have sex early in their lives but then choose to abstain.

When AIDS emerged in the early

1980s, prevention programs were first targeted to those hardest hit—men who have sex with men in major cities like New York, Los Angeles and San Francisco

According to the CDC, due in part to these sustained prevention efforts, the rate of new AIDS diagnoses attributed to gay and bisexual sex has decreased dramatically among white men in these cities between 1989 and 1994. Of concern, however, is the fact that in these same cities the rate of new AIDS cases attributed to gay and bisexual sex among African American and Hispanic men increased dramatically.

Developing World Hardest Hit

According to Dr. Peter R. Lamptey, project director of the AIDS Control and Prevention Project (AIDSCAP), the number of people infected with HIV is expected to reach 40 million by the end of the decade and most of the victims will be women and children.

Addressing the third HIV/AIDS conference sponsored by the U.S. Agency for International Development (USAID) last August, he said two-third of all HIV-infected people live in Africa, and 85 per cent of all infections occur in the developing world. He warned that the disease will "reverse most of the advances that have been made in developing countries in child survival and in life expectancy over the last couple of decades".

USAID Administrator J. Brian Atwood said the spread of HIV "is a development issue—it strike at those who should be in the forefront of development : young people, women, child. It robs nation of care givers; it destabilizes families, the basic unit of development; it taxes already overtaxed and often inadequate health care systems and, because the virus often is prevalent among militaries and police forces, it is also a threat to democracy".

Since 1986 USAID has invested more than $800 million in HIV/AIDS prevention and education programs in 42 nations. As an example of success in the prevention area, a USAID fact sheet notes that "condom use in Ethiopia has increased fivefold in the last four years". In Kenya, it states, "the increased use of condoms is credited with preventing 110,000 HIV infections and over 1.3 million other STDs (sexually transmitted diseases) since 1989".

Lamptey, who compared the AIDS epidemic with the bubonic plague, which killed 85 million people worldwide in the 14th century, noted that "all over the world, people with HIV/AIDS are victimized by discrimination and fear.

"Our capacity for ignorance and our tendency to take inappropriate, ineffective, and often harmful action against those with epidemic diseases has not improved much over the centuries. Society's reaction often hampers the control and prevention of these diseases".

Book Review

Fundamental Chemistry Part II for Class XII

By P.L. Soni, O.P. Dharmarha and H.M. Chawla, published by Sultan Chand & Sons, New Delhi, 1995 (Third Edition), pp. 1099, Rs 160.

THE enunciation of the National Policy on Education in 1986 (NPE-1986), followed by the Programme of Action (POA), necessitated the National Council of Educational Research and Training (NCERT), the apex body of our country to advise and assist the Ministry of Human Resource Development (MHRD), Government of India, for its school education programmes, to revise the curriculum for the entire school system of the country. The revised curriculum was so designed as to cover all the thrust areas stated in the above mentioned policy document. One such thrust area in the policy is the development of scientific attitude and scientific temper among the school children, as well as to develop in them the ability and courage to ask questions.

To meet the requirements envisaged in the revised curriculum is science for the senior secondary stage, the Department of Education in Science and Mathematics of the NCERT prepared the syllabi in different science subjects, viz chemistry, physics and life sciences. While formulating the syllabus in chemistry, various factors such as comprehension level of an average child, previous knowledge, some horizontal and vertical mobilities with the secondary science course, availability of time (allotted for instruction and practical work), availability of necessary laboratory facilities for doing practical work, and last, but not the least, the availability of a trained, innovative and motivated teacher, were borne in mind. This syllabus was subsequently prescribed by various State Boards of Secondary Education, including the Central Board of Secondary Education (CBSE), for the students who intended to appear at the Senior Secondary Examinations conducted by these Boards. However, the CBSE includes only the syllabus prescribed for Class XII in any subject in the Senior Secondary Examination conducted by it.

There has been a spate of textbooks in chemistry for the senior secondary stage in the market after the prescription of the syllabus in chemistry for this stage by the Central Board of Secondary Education. These textbooks have been published by both renowned and little known publishers. These books, on the one hand, have been authored by well-known subject experts and experienced class room teachers, whereas, on the other hand, some inexperienced authors have also ventured to write these textbooks in a bid to make some quick and easy money.

The present textbook, i.e. *Fundamental Chemistry* Part-II (for Class XII), has been written by experienced teachers and experts in the subject of chemistry, and, in the past, they have written many

useful books on this subject. In this textbook, in the beginning of each unit, the number of periods allowed to each unit and the marks allotted to it in the final examination have been mentioned : whereas the former information is of immense help to the teacher for limiting the classroom instruction, the latter information is useful for the student for it indicates the weightage to be given to each unit for the purpose of preparation for the Board's examination. The portion of the prescribed syllabus that a unit covers is also given in the beginning. This is very helpful to the students for planning their studies.

The coverage of the subject matter vis-a-vis the prescribed syllabus is more than adequate. It also provides intellectual food for those students who want to know a little more than what is prescribed in the syllabus. The fundamental principles and basic concepts of chemistry have been presented in a simplified manner for a better comprehension of students. However, in some units, the treatment of subject matter is quite exhaustive which may help those students who prepare for pre-engineering and pre-medical entrance examinations. The authors, at some place, have not been able to shed off their liking for the classical chemistry.

This book is an example of a good textbook writing. The authors have used thermodynamic data for explaining 'Whys' and 'Hows' at several places. The IUPAC system of conventions has been used in the book, although, it being the transitional stage, a limited use of the new conventions of the IUPAC has also been made.

The structural aspects of chemistry, viz. atomic structure and chemical bonding, have received special attention keeping in view the importance of the subject matter. Similarly, a greater emphasis has been placed on the mechanisms of chemical reactions. Some of the latest developments in nuclear chemistry and surface chemistry have been included.

The language of the book is lucid so that the subject matter is easy to grasp. The presentation of the subject is rigorous and scholarly. The diagrams are well-labelled and the necessary legends have been given, although there is scope for improving upon the quality of diagrams. The printing of the book is not up to the mark.

The whole approach of the textbook is building up the subject matter from the fundamentals to the more complex advanced modern concepts. Therefore, the book makes an intelligent and enjoyable reading. For a better comprehension of the subject matter, a very large number of solved examples has been given in the book. For a continuous comprehensive evaluation of the learners, the authors have included a variety of questions, viz. very short answer type, short answer type and objective type, interwoven with the textual matter. For brighter students, some challenging problems have been added at the end of each unit. These problems may be helpful in the training of minds of those students who intend to appear for pre-medical and pre-engineering entrance tests. The authors would have done well by giving some hints to the students at the appropriate places for solving some of the complex problems. Similarly, there is scope for the improvement of some of

the objective type (multiple choice) questions. Distractors of the type "None of these", "These cannot be compared", and "The question is wrong" should have been avoided. The notations used are also at variance. At some places they are (A), (B), (C), and (D), whereas at the other places they are (a), (b), (c), and (d). Moreover in a multiple choice question, the task to be performed by the student should be set in the stem itself of the question, rather than making such questions "completion type" or "fill in the blanks type".

The book is meant for those who are motivated to study chemistry as a specialised discipline of science at an advanced level and intend to appear for the Class XII examination, especially of the Central Board of Secondary Education. It is also suitable for those who intend to appear for pre-engineering and pre-medical entrance tests. Many teachers of the secondary level science will find this textbook as a good reference book. The book is worth purchasing as a valuable addition to secondary and senior secondary school libraries, and personal library.

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SCIENCE RELATED VALUES

Curiosity, quest for knowledge, objectivity, honesty and truthfulness, courage to question, systematic reasoning, acceptance after proof/verification, open-mindedness, search for perfection and team spirit are some of the basic values related to science. The processes of science, which help in searching the truth about nature and its phenomena are characterised by these values. Science aims at explaining things and events. Therefore to learn and practise science :

- **Be inquisitive about things and events around you.**
- **Have the courage to question beliefs and practices.**
- **Ask 'what', 'how' and 'why' and find your answers by critically observing, experimenting, consulting, discussing and reasoning.**
- **Record honestly your observations and experimental results in your laboratory or outside it.**
- **Repeat experiments carefully and systematically if required, but do not manipulate your results under any circumstance.**
- **Be guided by facts, reasons and logic. Do not be biased in one way or the other.**
- **Aspire to make new discoveries and inventions by sustained and dedicated work.**

SCHOOL SCIENCE

...XXXIV NO.3 SEPTEMBER 1996

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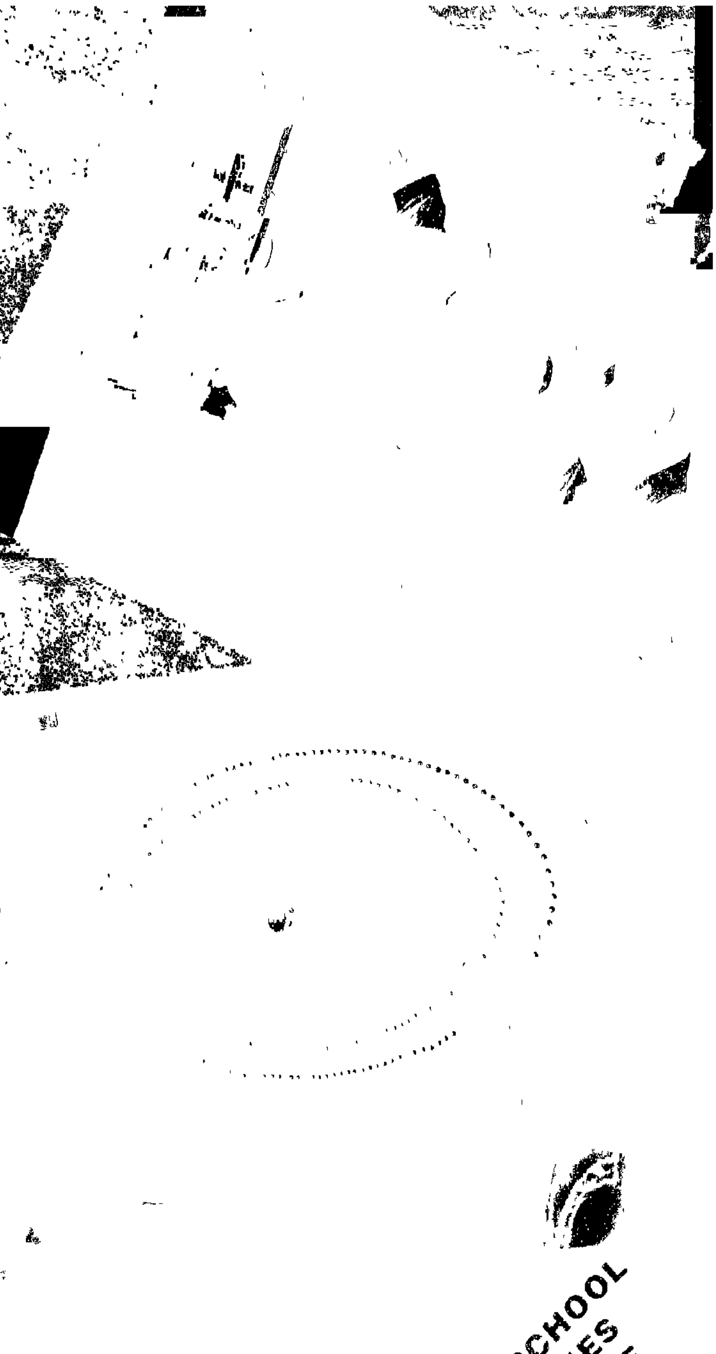

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SCHOOL SCIENCE is a journal published quarterly by the National Council of Educational Research and Training, New Delhi It aims at bringing within easy reach of teachers and students the recent developments in science and science methodology, and serves as a useful forum for the exchange of readers' views and experiences in science education and science projects.

Articles suitable to the objectives mentioned above are invited for publication. An article sent for publication should normally not exceed ten typed pages, and it should be *exclusive* to this journal. Illustrations should be drawn with pen and indelible Indian ink Photographs (black and white), at least of postcard size, should be on glossy paper, and should be properly packed to avoid damage in transit

Manuscripts with illustrations, charts, graphs, etc. along with legends, neatly typed in double space on uniformly sized paper, should be sent to the Executive Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

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Down the Memory Lane
Photo Feature on Science Exhibition

Cover Transparencies

TO OUR CONTRIBUTORS

SCHOOL SCIENCE *invites articles from teachers, acquainting students with recent developments in science and science methodology. The articles should be addressed to the Executive Editor, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016*

About this Issue

Although indiscriminate exploitation of some achievements of science and technology for fast gains have come in for sharp criticism, there is hardly any scope to deny the role of science in human progress. Science and technology are the very bases of modern industry and agriculture. They have transformed the mode of transport and communication, treatment of diseases, entertainment and crime detection. They have revolutionised storage, processing, and retrieval of information tending to alter the nature.

It is no wonder that science and technology have become a powerful institution supported and protected by all modern states for attaining supremacy over others.

Science is not only a body of knowledge but also a means of generating it. Methods of science are being increasingly used for other disciplines. Science also holds the key to liberation from narrow barriers of obscurantism and prejudices. But above all, science is a great creative endeavour of human mind no less than any branch of human pursuits.

In fact, the influence of science has been so profound in human life that it is often said that we are living in the age of science, not realizing that we are living just at the threshold of it as compared to the future generations. And India as a nation has only touched the edge. Past experiences indicate that a society either adopts science whole-heartedly or falls victim of it. In this critical juncture of human progress any dilution in the efforts of adopting science would be perilous for a nation.

If education has to play its role as an instrument of social change, science education has to be strengthened both in and out of the four walls of the classroom. The formal classroom instruction is highly structured, rigid and understandably a part of it consists of routine drills. It is the out-of-school activity in its very spectrum that children can get a feel or fun of science, can get the experience of the process skills and unleash their creativity. Out-of-school activities are generally close to the interest and problems a child perceives. Displaying the products of such activities through exhibitions bring the community nearer to science. Therefore, out-of-school activities in science should be given all institutional encouragement for expansion and proper guidance for improvement of quality.

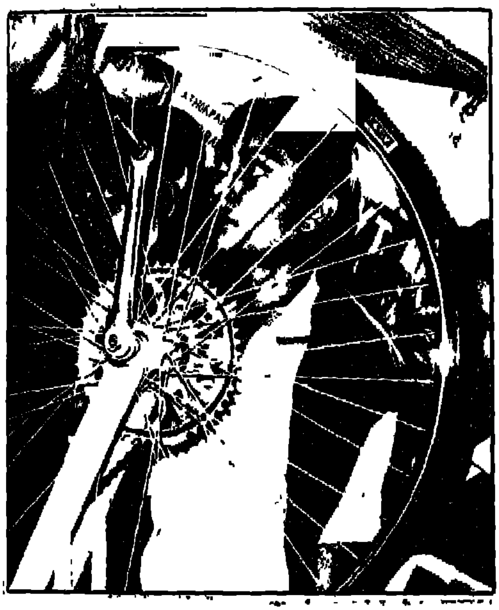
Quite a few significant contributions have been made by people pursuing science as their hobby, in spite of the fact that nowadays scientific research requires very sophisticated equipment and infrastructure. For instance, the prototype of a radio telescope was first developed by an amateur, Grote Raber. Incidentally, the first person to report in 1931-32 that the radio signals are being received on the earth from interstellar space was not an astronomer, but an electrical engineer named Karl Janky. The radio telescope developed by

Raber confirmed this observation. The credit for discovering a number of celestial bodies like comets, asteroids, moons of planets and stars goes to many amateur astronomers. In 1995, a new comet was sighted by an amateur comet hunter, Yuji Hyakutake. The comet approaching towards earth has since been named after its discoverer as 'Comet Hyakutake'. Another noteworthy discovery in recent past has been sighting of the Comet de Vico in 1995. The comet last seen in 1846, was considered to be lost forever by the astronomers. Three amateur astronomers, viz. Yiji Nakamura, Songo Utsunomiya and Masaaki Tanaka, all from Japan, independently discovered this comet. Such instances provide us with enough indications that if nurtured properly the out-of-school activities can be carried out at highest levels.

This issue of *SCHOOL SCIENCE* is being brought out as a special number of Out-of-School Activities in Science to coincide with the completion of 25 years of the National Science Exhibition for Children as also the 30th year of launching of science club movement in our country.

Science Club Activities

V.B. KAMBLE
National Council for Science and Technology Communication Department of Science and Technology
New Delhi



To nurture and retain the scientific temper among children, it is necessary to impart encouragement, guidance and a bare minimum of facilities so that they can satisfy their curiosity and pursue their individual interests and hobbies. It is for this purpose that science club activities assume even a greater importance than the classroom activities. In this article, we shall briefly discuss various possible science club activities at schools and related aspects.

Getting Started

Quite often, the only science activity in a school is that of a science club and the number of such schools may only be miniscule. Attempts to set up a science club in a school often meet with only a limited success, perhaps due to the fact that the teachers may not be able to devote time for the club activities after school hours or on holidays or there may not be any space available, or due to financial constraints. But, most important factors for the science clubs not functioning well, or not functioning at all, are the lack of initiative and ideas. It is, of course, desirable that some space is made available, preferably at the school premises itself, to conduct the club activities even after the school hours or on holidays The space could be used for discussions, storing materials and as activity areas for children. However, when the space is not available, either at school or at some other place, it is always possible to conduct several outdoor activities like sky-viewing, model rocketry, activities related to environment and those utilising folk media like science kits, street plays etc.

Contrary to the belief, the requirement of funds is really not high. In fact many of the activities could be conducted at a very low-cost or even at no-cost. Most schools do have some funds, may be small, for extra curricular activities. Unless activities involved require purchase of kits, apparatus, equipment etc., the total fund requirement may not ordinarily exceed Rs 10 per month per child. A nominal fee of Rs 5 per month, wherever possible, could cover the cost of materials partially. Needless to say, it is expected that teachers/volunteers

work with a spirit of voluntarity and make their time available free of cost!

Availability of Teachers/Volunteers

The science teachers of the school themselves could offer to conduct the science club activities. It is always possible to locate resource persons who would be willing to conduct activities in specific areas free of cost. Quite often, the senior members of the club, say, students of secondary/higher secondary classes could assist—even conduct activities they have gained proficiency in with their juniors. It may be stated that they enjoy doing so and that they do it with the utmost sense of responsibility as our experience suggests. The very feeling that they are facilitating the learning process of their juniors is a reward in itself. Further, this imparts an opportunity to them to develop their presentations, skills and leadership qualities.

Suitability of Time!

That the activity time should be suitable to the students needs no overemphasis. But, it needs to be ensured that the club remains open during that period. (We have assumed that some space has been made available for the Science Club Activities!). If the teacher-in-charge of the club cannot remain present, the responsibility could be shouldered by the volunteers or the senior students. For this purpose, it is necessary to trust them and also make them feel responsible. Incidentally, this strategy almost always works!

Accessibility

It is not only desirable, but also essential that the club facilities are also extended to children from other schools, or even to those who are drop-outs. If encouraged to participate in the club activities, it is likely that their interest in science in particular and education in general may be rejuvenated. It may even inspire them to come back to the school once again. No rigid rules need to be framed which only hamper the access to the club.

General Activities

It needs to be borne in mind that teachers/resource persons are also active participants in the club activities. They further shoulder the responsibility of devising and conducting activities suited to various age groups, say, at primary, secondary etc. We shall briefly discuss the types of activities which could be taken up. Surely, it may not be possible to conduct all the activities discussed here at every club due to want of suitable resource persons, materials or space. It may, however, be stated that information to initiate these and many other activities not discussed here is readily available—in the form of resource and activity books or kits. It should not prove too difficult to get the names and addresses of interested resource persons/organisations specialising in various areas. True, some of the activities mentioned here may need extra support either from the school or other sources.

General activities of common interest and awareness type could be conducted at community level as well Popular science lectures/demonstrations, slide shows, video/film shows, exhibitions could be taken up by the members of the club under the guidance of teachers and resource persons. It is even pos

sible to organise activities/competitions with specific scientific themes from time to time on, say posters, essays, quiz, stories, fiction, elocution competition etc. It is advisable that the organisational responsibilities of these activities—to the extent possible—given to the members of the club.

Specific Activities

We mention a few specific activities for the school science clubs below. Many of these in fact could develop as hobbies :

Science Wall Newspaper : A Science Wall Newspaper— a fortnightly or a monthly — brought out entirely by children themselves is an activity that could go a long way in stimulating an interest in science along with sharpening reading, reporting and writing skills of the children. Children may contribute science news items collected from various sources; and with necessary editing could be reported in the newsletter. The art teacher/resource person may help the children prepare the layout. Various teams could be formed to take care of different departments of the newsletter such as news item/article collection, editing, lay-out, writing etc. This activity initiated by the author at several urban/rural schools has caught the imagination of children and teachers alike and has continued on its own over the years.

Origami : Origami, or the art of paper-folding, is a wonderful synthesis of art and science, and what is remarkable about it is that it is suited at every level and enjoyed by young and old alike. Not only origami is fun making various shapes and toys with paper, it can also be effectively utilised for learning a number of concepts in mathematics. Concepts like symmetry, geometrical representation of some of the algebraic identities and set theory can be easily understood through this fascinating activity.

Astronomy : This is an activity suited to all the age groups including at the community level. It could range from familiarity with stars and constellations to projects at various levels. If a small telescope is already available at school, it could be effectively used for the purpose. In case a portable planetarium is available with the school or in the vicinity, it could add a further dimension to the astronomy activities.

Nature, Ecology, Environment : This is yet another activity suited to all age groups. Activities could range from awareness programmes and simple projects to even surveys, say on water/air pollution, the flora and fauna of the region, types of soil, agricultural practices, types of fuels used etc. It would even be possible to consider activities on issues with social relevance like a survey of unscientific practices, traditions and beliefs, superstitions etc.

Health and Nutrition : It is possible to involve children in several interesting activities related to health, nutrition, hygiene and sanitation. For example, with a small plastic microscope (costing about Rs.50 and magnifying the image by a factor of 60 to 100), the children may be encouraged to test water samples from different areas or observe small organisms and record their observations. It may be interesting to note that young school girls in a remote village in

Madhya Pradesh traced the white lines on the green leaves due to a tiny insect of size only 1mm and not due to the curse of the snake god as was widely believed by the local people ! Children could also be engaged in surveys such as the type and quality of food being consumed in various households, common diseases and collecting information/suggesting ways to take preventive measures, etc.

Electronics : With the advent of radio, TV, computers and satellites, electronics has caught the imagination of a number of children. Further, this activity/hobby could be pursued at any level. It may be necessary to store some common components like resistors, capacitors, transistors etc. The club could provide facilities like soldering iron, solder, multimeter etc. and some technical guidance at times. When a child has made a device, quite often, he/she may like to possess it! In such an event, he/she could be asked to replace the components. The experience shows that this strategy works! Several books on simple projects/activities in electronics are available in the market.

Model Rocketry : In this activity, children, prepare working models of rockets with paper. For the engine i.e. the fuel they use the fuel part of the Diwali rocket. Single, double and triple stage rockets and rockets with a recovery mechanism (parachute) could also be made. They also learn how to find height attained by their model rocket using a tracking mechanism also to be fabricated by them. This activity imparts immense possibilities and scope in learning basic concepts of mechanics, aerodynamics, application of mathematics, and most important, they develop team-spirit, working as an integral part of the group. Materials required are mostly available locally.

Photography : This activity may require equipment like camera, enlarger, a few chemicals and a dark room. In fact, even a cheap box camera would do. Besides, becoming familiar with concepts of optics, it is possible to develop several professional skills. Photographic films are a bit expensive, but this is a great device for learning environment for the children. Unfortunately, because of high costs of materials, it may not always be possible to introduce this activity in a large number of schools.

Amateur Radio : This is truly an exciting and a thrilling hobby, though it may require some investment. It is possible to set up a radio station and communicate on specified bands of radio frequencies— the amateur or ham bands — if one has a licence, i.e. the Amateur Station Operator's Licence issued by Ministry of Communications. To obtain the licence, it is necessary to pass Amateur Station Operator's Certificate Examination conducted by the Ministry of Communications, consisting of basic radio theory, rules and regulations and communications on Morse code. The sheer thrill of talking to ham operators spread throughout the world is an experience by itself. You literally have the whole world in your room! It is possible to set up an individual ham radio station at one's own home or a club station. Those who are technically oriented can fabricate their equipment and antennae. Imported equipment being quite expensive,

amateurs often choose to develop less expensive amateur equipment themselves. In fact, a 7 MHz transceiver for communication on morse code could be fabricated for Rs 1000 only. This hobby could be effectively used when the normal channels of communication fail, say for relief operations following floods, earthquake etc., but cannot be used as a replacement to conventional modes of communication, say telephone! A network of monitoring stations throughout the country monitors the entire radio frequency spectrum for any possible clandestine use of this activity.

Activities Employing Folk-Media

Activities involving folk media, say production of street plays on scientific topic, drama, science songs, puppetry etc., encourage creativity and bring to life the dormant talents of the children. Through activities related to folk media, it is possible to mix a message/information with entertainment. The undersigned may be contacted for the names of resource persons/organisations who could organise workshops/training progress to initiate these activities at the School Science Clubs.

Get Going, Then!

The activities of the type of model rocketry, amateur radio, etc., not only generate an interest in science and technology, but also train the children to approach a problem in a scientific way. Besides, they learn to work in a team where a good deal of co-operation, co-ordination

Activities Suited at Different Levels

Primary Level	*Secondary Level*	*Higher Secondary/ College Level*	*General Community Level*
Simple experiments	Model Rocketry	Fabricating devices in Electronics/Ham Radio	Audio/radio/video programmes
Model making	Use of telescope	Courses for Ham Radio	Slide shows
Sky viewing	Telescope making	Courses for Ham Radio	Popular lectures
Demonstrations	Simple projects and analysis of data	Demonstrations	Lectures/Demonstrations at popular level
Quiz	Demonstrations	Developing Computer Software	Astronomy/sky viewing
Classification of data, say types of trees, leaves etc.	Spectra of elements	Essay competition	Conducting ham radio courses/demonstrations
Field trips	Use of camera	Quiz	Demonstration of computer simulations
Exhibition of model made by students	Science wall paper by students	Photography	Exhibition on various aspects of Science and Technology

Primary Level	*Secondary Level*	*Higher Secondary/ College Level*	*General Community Level*
Skits/Plays	Debates Field trips	Field trips Writing articles	Use of folk media— street plays, skits, drama, songs, puppetry, etc.
	Quiz	Investigative projects	
	Workshops	Workshops	
	Exhibitions	Exhibition Debates	
	Skits, drama, songs street plays, puppetry	Skits, drama	

and discipline are required. These are some of the qualities that lie at the heart of every scientific endeavour.

In this article, we have outlined the formation of science clubs and a few possible activities. Ofcourse, a host of other actrivities are possible say Origami, scientific explanation of miracles, aeromodelling, activities related to space science and technology, computers and software development, etc. The club activities suited to different age groups are indicated in the box. The list is by no means complete, but only indicative of the variety of activities that could be undertaken at the school science clubs.

The National Council for Science and Technology Communication (NCSTC) would be happy to help you with the necessary information on initiating a particular activity at your Science Club, on availability of books, materials and resource persons including technical aspects. It may even be possible at times to partially support an activity, however, it may not be possible to extend support for establishment of a Science Club. Please do write to us for details/enquiries about any aspect related with science communication/popularisation along with your suggestions, if any.

NOTES

1. Dr. V.B. Kamble is Director at the National Council for Science and Technology Communication (NCSTC), Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110016. NCSTC is the nodal agency of the Government of India for Communication/Popularisation of Science and Technology in the country and inculcation of scientific temper among the people A few of the major programmes undertaken by NCSTC over the years included *Bharat Jana Vigyan Jatha* (1987), 1992 Radio serials *Vigyan Vidhi* (1989) and *Manav Ka Vikas* (1992-1994) broadcast in various Indian languages simultaneously from all the stations of AIR, and TV serials *Bharat Ki Chhap* and *Kyon aur Kaise?* NCSTC also has brought out a number of publications on Science and Technology at popular level Dr. Kamble can be reached on the above address and would be happy to share his information and experience with readers.
2. This article had originally appeared in the July 1994 issue of *NCSTC Communications*, the monthly newsletter of NCSTC. It has been suitably modified to suit the requirements of the *School Science*.

Out-of-School Science Activities

A Profile

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Formal science education has not been able to keep up with the fast development in the area of science and technology. It is not intended to make everyone scientist or technologist but it is desirable and possible that everyone knows about science and technology to the extent that consequences and social applications of science are understood. At present the exposure to science for those who are not aspiring to be scientists or technologists is not sufficient to create significant awareness. Out of School Activities (OSA) has to take over from where formal classroom discourses in science to the beginners in the junior classes have failed to deliver. Science clubs, science fairs, camps, museums, meetings have already been institutionalised in many countries and listed under OSA. Locales for these activities include schools, homes, community centres, clubs, factories, shops, farms, deserts, beaches, forest, lakes, seas... anywhere. Driven by the interest in science, young and old alike join the science club to get something which is not provided in the classroom. For the budding scientist it provides excellent scope for exploration. Such activities fix the realisation that "science is something which is done" and not merely "something which is learnt". OSA both compliment and supplement science education. The definition of OSA coined by the International Coordination Committee (ICC) for the presentation of science and development of Out-of-School Scientific Activities is: OSA refers to "educational activities undertaken or done outside the formal teaching periods and the formal curriculum. An activity is out-of-school even if it takes place within the framework of the school; even if it takes place in a free activity period what is normally part of school working day".

OSA have the following target groups :

(a) The formal school children.
(b) The children and adults who drop out from schools and join the world of work who need to be given scientific literacy.
(c) Educated adults who want life-long education under the pressure of rapid changes in science and technology and the society.

Ideally OSA need be organised on the following principles:

There should be access of children to the formal education as well as out-of-school education, the latter being authentic and well established.

Both theory and practice in science and technology education should be given equal importance.

Each young person has to be given chance to join creative activities of the society so that overall and harmonious development is possible.

Success Stories of OSA in Different Parts of the World

A. Science Clubs

Science clubs in America are one of the oldest and the largest. These are formed by teachers, students, professional scientists, parents and all. There are thousands of such clubs. Most of the clubs are connected with schools and they meet sometimes after the school and even during the school. The contribution of France in this direction is the concept of laboratory club. Here the budding scientists can use well-equipped laboratories outside the school in all the major cities of France. The project covers design and construction of sophisticated applications even like rockets. Such clubs encourage astronomy, biology, geology, physics, aeronautics and electronics. Besides, it also undertakes courses, conferences, visits and camps. In the UK we have seen the movement of 'Project Technology' in schools and various innovative publications by the Schools Council. In the erstwhile Soviet Union, an increasing number of young students were involved in scientific activities based on the contention that future science depends upon the speed with which scientists pass on their knowledge to the youth. As a result, around 1970, out of the seven lakh scientists (25% of total number in the world at that time) working in research establishments of higher education there, almost half were less than 30 years of age. They possessed a revolutionary spirit and driving force outside the world of monotony of laboratory rituals which enthused them to scale new heights in innovation. This trend helped each student to find her/his vocation so that there is greater challenge and job satisfaction in their future career and so it linked education with productive work through experience, training or apprenticeship. In the erstwhile Soviet Union one could explosion in the production of popular books on science, fictions, science programmes on radio and television.Olympiads started with mathematics particularly for students of 7th to 9 th grades. Olympiad became an international movement through the initiative of erstwhile Yugoslavia. There were Junior Academy of Sciences in the then Soviet Union which conducted Olympiads, competitions, discussions and created platforms for young stu-

dents to write articles, construct apparatus, take on them research projects from scientific institutions and industrial undertakings. The Pioneer Palace of Moscow which was established in 1962 provided all possible activities for the budding scientists e.g. gymnastics, swimming, parachuting, astrophysics, astronomy, biology, rocket technology, astronautical science and space science. Young inventors designed hundreds of pieces of machinery including machines for moulding instruments and medical equipment which were actually put to use. There used to be a competition 'Young technologists' service to the country once in every two years since 1962.

The nation got new designs of instruments and technical devices as well as cars and tractors and machine tools. Besides there were organised young naturalists who used to utilise the school holidays in the research and production activities in the agricultural firms. The scenario in the erstwhile USSR has been encouraging as the young scientists working in clubs blossomed into scientists and technologists of high calibre.

In Sao Paulo, Brazil, an institute called IBECC introduced simple kits to encourage children to make discoveries. Interestingly a report had said that Brazilian children generally don't like to work with their hands. So this institute tried to bring a revolution and could succeed in establishing many science clubs. The clubs were generally housed in empty garage, or cellar, and the furniture and equipment were borrowed or begged from any source. These science clubs undertook studies on mutations in living creatures, preparations of geological maps, processing of industrial wastes, diseases of coffee tree, influence of sunlight on Vitamin C, content of cow's milk, dental caries, chlorine content of drinking water, nutritious value of bread, pollen sediment, archaeological remains, water pollution etc. In China science club movement began in 1962 and now they have spread over primary schools, middle schools, colleges and other institutions.

In India, the science club programme was initiated in 1957-58 and by 1962 about 500 clubs were established with the help of central aid of Rs. 1200 each. Efforts were made to establish science clubs in about 5 per cent high schools and higher secondary schools of the country. By 1966 there were about 910 clubs. In 1965 the NCERT published a book titled *Organizing Science Clubs*.

This book highlighted training motivation, finance, organisation activities e.g. paper reading, symposia, quiz, essay competition, lectures, film shows, excursions, workshop practice for preparation of models, collection and preservation of geological samples, and conducting experiments The publication also provided details on how to do a science project and listed 83 possible areas for projects.

Besides, NCERT, the NCSM (National Council of Science Museums), Bal Bhawan Society, NCSTC (National Council for Science and Technology Communication), KSSP (Kerala Shastra Sahitya Parishad) have made significant contribution in popularising science, particularly among school children. KSSP has attracted many young people

of Kerala to build around them groups to take science to streets. They have composed many plays and songs in English, Hindi and Malayalam. Titles of some of their poems are 'Oh Universe', '$E=MC^2$' 'Atom', The Earth'. Many organisations in each State/UT are carrying out OSA. Five hundred such groups and twenty-six People's Science Movement groups from all over the country organized first ever *Bharat Jan Vigyan Jatha* in 1987 under the overall leadership and guidance of NCSTC. Seven to eight million people were covered by the procession and many more got exposure to science through media. NCSM with its national, regional, sub-regional and district science centres totalling forty, Bal Bhawan Society with its two hundred centres and NCSTC support workshops, essay and painting competitions.

B. Science Museums

The list of large and small science museums and technology museums, planetaria, and natural history museums around the world is almost endless. The notable feature in India today is that NCSM has established national, regional, sub-regional and district science centres dotted over the country; a unique Science City at Calcutta is the latest addition. Proliferation of their programmes tend to cover almost everybody in their respective catchment areas. The expertise of NCSM is now being utilised by many countries in building up science museums and exhibits. Birla Industrial and Technological Museum, Calcutta which was subsequently taken under NCSM, was the first technological museum in India. Besides, there are other museums like Birla Museum at Pilani, National Museum of Natural History, New Delhi, planetaria, zoo gardens, aquaria, science parks in many states. Many museums have exhibits of three levels. The first level caters to the need of 4-9 year old children where the children can find the answer to 'what' and 'why'? The second level exhibition is for children in the age group of 10-16 years. At all levels they get stimulation, motivation and intellectual excitement and awareness. At the third level frontiers of science are discussed by the renowned scientific minds. The presentation and activities vary from museum to museum though the overall goal of all museums is basically popularisation of science and technology.

C. Science Fairs

Science fair is one of the very important activities generally organised by science clubs, museums, national bodies, institutes. The USA is one of the pioneers in organising science fairs under the aegis of Science Clubs of America. Now international Science Fair is organised in many countries including the USA and Japan. One of the important aspects of such science fairs is science talent search. The programme of science fairs in the UK started as an event for the secondary school only. They expanded to include primary schools, colleges of education, university departments, industrial firms, nationalised bodies, public undertakings etc. An average fair in the UK has participation from 50-100 schools (radius of 45 km from the site of fair) contributing 70 to 150 projects. The fair is held generally during 3-6 days. Science fairs are also held regularly in many countries such as

Australia, Britain, Chile, Taiwan, Columbia, Costa Rica, Gautemala, Hungary, Mexico, the Netherlands, the Philippines, Spain, Thailand, Uruguay etc. In recent years Maldives and Nepal organised science fairs with the assistance of UNESCO. In science fairs the American model of participation is based on "individual project". In Germany, however the fair contains both individual projects as well as group projects. Each school in Japan has its own science fair and they also send their projects to 46 pefectural fairs. The experts of these countries suggest that the lead period of at least 18 months are required between the decision to hold the fair and the firm date of the fair itself.

In India, the NCERT will be holding the 23rd National Science Exhibition for Children this year. This has become the culmination point of a multi-tier exhibition system. The first level exhibitions are organised at district level. The second level at zonal or regional level and then by the state level. Finally, selected exhibits from the state level are considered for the national level exhibition next year. Thus the cycle time is two years. The OSA movement in India initiated by the NCERT has found success in the National Science Exhibition for Children which is being held almost every year during the last twenty-five years. The exhibition is generally inaugurated by the Hon'ble President of India. The number of exhibits in the National Science Exhibition every year are 160 (average), which are displayed for eight days and which are visited by about 5000 visitors every day. These exhibits are generally of seven major types e.g. improvised apparatus and model, communication, transport, energy, agriculture-food, environment pollution, health, industry and innovation in technology. Every year new themes are given on contemporary issues of science and social concern. Generally the largest number of exhibits are in the area of improvised apparatus and model. Recent events like satellite communication, rocket launching, laser technology, solar energy are also depicted in the form of exhibits. During the long journey of 25 years, the need of the participants have made the management bring out new innovations like Science Club Kit and Mini Tool Kit for the children. These are portable tools and instruments for light duty fabrication. Simultaneously a book titled *Science and Technology Education through Exhibitions* have also been published by the NCERT, it is written for the managers of the exhibition, teachers and mainly for the participating children. While the managers have been given information about the lay out of the site, site requirement, management etc., the children have been given tips about selection of topics, how to overcome problems at different stages and how to work with tools and instruments.

OSA and Science Curriculum

Exposure of concrete operational children to OSA prepares them for the next stage. Formal operational children at the upper primary level have just the appropriate mental development to receive and enjoy OSA. The National Policy on Education—1986 aimed to strengthen science education in schools so as to develop in the child well defined abilities and values — enable the learner to acquire problem-solving and decision-making skills and to dis-

cover the relationship of science with health, agriculture, industry and other aspects of daily life. The Government of India launched the Scheme of Improvement of Science Education in schools in 1988. Under this scheme 100 per cent assistance was given to states/UTs for making provision of science kits to upper primary schools, upgrading laboratories in secondary and senior secondary schools, among others. The specifications of the NCERT Integrated Science Kit were given in the GOI's publication No. 1613 to promote classroom experimentation and hands-on activities at the upper primary level.

Almost all existing curricula of science prescribed in different states/UTs at the upper primary stage provide enough scope to cull out a variety of activities/projects/experiments which can be undertaken within the scope of OSA. For example, the science textbooks for Classes VI, VII and VIII developed by the NCERT have in all 47 chapters which encompass physical sciences, life sciences, earth science, health, agriculture and environment. All these areas are also covered in the science curricula of secondary levels.

It is quite apparent that there is tremendous scope of OSA and hands-on-activities and learning would be incomplete without these. But in reality, what is hap-

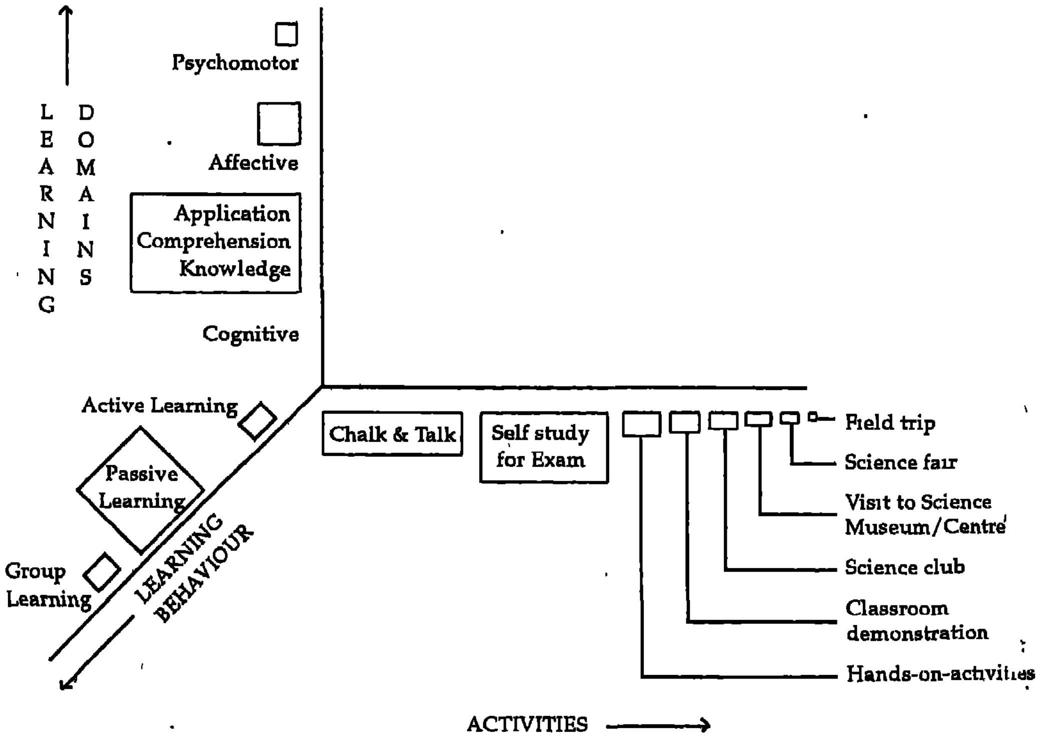

Fig 1. Science learning through formal classroom transactions in an average school at the upper primary level cast in three dimensions. The size of the boxes are roughly proportionatly to the magnitude of the concerned event

pening generally in schools is depicted in Fig 1.

Chalk-and-talk and self-study for examinations are the major activities while classroom demonstration, hands-on-activities, OSA are insignificant. The learning outcomes, by and large, are restricted to Bloom's knowledge component which is mostly rote learning. Interestingly many schools are using science books which present each chapter in Question-Answer form, NCERT textbooks are prescribed for the same schools but those are not even opened. Due to cumulative effect of all these, the children are deprived of the joyful journey through the process of science, e.g. observation-classification-number relations-measurement-space/time relations communication-prediction-inference-making operational definitions-formulating hypothesis interpreting data - identifying and controlling variables-experimenting. Not only they are deprived of the pleasure of controlling variables and discovery but they are made to lose respect for these under the atrocities of pronouncements in the classroom and Question-Answer textbooks. The NCERT textbook *Science* for the upper primary evolved itself in the process of growth in the integration of science and social studies.

The children in the age group of 12-14 years in the upper primary have just crossed the concrete operational stage and entered into the organisational sub-stage of the formal operational thought. At this stage a science learner starts realising the importance of changing one variable at a time while keeping others constant. If a child of this age group is given a glass tumbler, a bowl and a big dish containing water and asked to find out the conditions for maximum evaporation, s/he will enjoy working with one variable at a time and will definitely be able to arrive at the correct inference. S/he will also develop other qualities if s/he works in a group. Piaget confirms that learning depends on the learner's actions. So there is no learning without action at this stage.

In Conclusion

The weaknesses of classroom transactions in science at upper primary stage are apparent in Fig.1 the neglected areas are OSA, hand-on activities, active learning, group activities and learning in affective and psychomotor domains. For entering the next century and for keeping pace with the explosion of scientific and technological knowledge, there should be an immediate change in the learning strategy to give importance to OSA activities for a purposeful and joyful learning.

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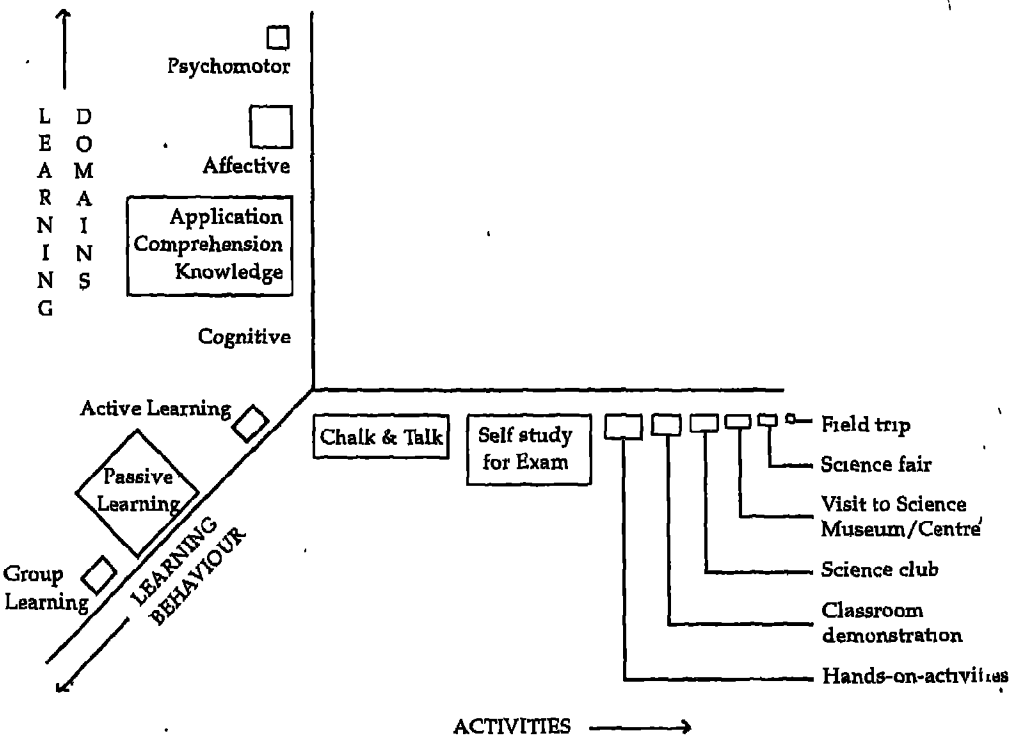

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Out-of-School Activities in Science

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Out-of-school activities in science refer to any science related activity undertaken by a student which is not a part of prescribed curriculum. These activities provide a unique opportunity to an individual to ; (i) develop ability to operate independently, (ii) ask why and how about any event encountered by him, (iii) plan and investigate about any area of his interest, (iv) design experiments, (v) design and fabricate models, (vi) nurture creative abilities and communication skills, and (vii) develop decision-making skills and leadership. Although a majority of the above traits form a part of stated objectives of the formal science curriculum, but they are seldom reflected in its transaction in schools. However, the decision to participate in out-of-school activities in science is voluntary. The possibility of developing some of these abilities are, therefore, much brighter. If properly planned and carried out these activities can, therefore, act as supplementary to the efforts of formal science education in schools.

Nature and Scope

As the name suggests it seems that out-of-school activities in science ought to be carried out outside the school premises. However, this inference is not correct. These activities can be performed within the school and can even utilise its laboratory and other resources provided participation in them is voluntary and they are not a part of the prescribed curriculum. One may like to ask which type of activities can be categorised as out-of-school activities in science. Broadly speaking, any activity chosen voluntarily to learn or investigate any aspect of science could be considered as an out-of-school activity. Their range may extend from reading an article on a scientific topic to investigating a complex natural phenomena. However, every out-of-school activity ought to be carefully planned and executed ir-

fail to create the desired impact. Once a decision to conduct an out-of-school activity is taken it is desirable to specify its objectives and identify the target population. Other pre-requisites are decision about the location where the activity would be undertaken, its timings and above all the assessment of required resources and facilities. The interests of the intended target population have to be considered while planning an out-of-school activity to ensure voluntary participation

The out-of-school activities in science may be conducted in many ways. For convencience these can be organised as (i) science clubs, (ii) science camps, (iii) symposia, seminars meetings, quiz, essay writing or debate competition, (iv) museums, (v) investigatory projects, and (vi) science exhibitions. It is possible to organise one or more of these activities under one umbrella say science clubs. In this article, only the role and functions of science clubs and science exhibitions will be discussed in some detail.

Science Clubs

A club, be it a football club or a hobby club, is formed because some people are interested to collectively pursue some commonly agreed interests. Similarly, a science club is formed if some individuals are interested to work together to explore one or more areas and/or aspects of science. But science is taught in schools, therefore, the aim of a science club must be to provide its members something which is not to be covered by the prescribed curriculum or by the school even though it is expected to be related to the curriculum.

A science club, may, therefore, provide a unique opportunity to its members to avail of some extra excitement or enjoyment and at the same time further (beyond the classroom) sharpen their process skills of scientific investigation. The science clubs may provide a forum to make its members realise and accept the fact that the best way to learn and enjoy science is by doing and not merely reading or listening about it. The activities conducted in them may also help to realise that an experiment is designed and conducted to find out something unknown and not to confirm an already known result as is often true for the pratical exercises prescribed as a part of school science curriculum.

There are a few basic requirements for establishing a science club. Some of these are—a leader or a sponsor who takes the initiative to form the club, a regular source of funding to carry out its programmes and activities, and a place where it can function. The leader or sponsor of the science club could be a science teacher or any other person engaged in some other profession having interest in pursuing science. Instead of an individual, formation of a science club can also be initiated by a small group of people. The source of funding for science clubs may be in the form of individual contributions by its members, donations and/or grant from governmental or non-governmental agencies. For a proper management of funds as also for the satisfaction of contributors, it is imperative that each sciene club must have some rules and regulations for proper maintenance of records in respect of receipts and expenditure of funds besides its stocks and the proceedings of its activities. Rules and

regulations also need to be framed to maintain a proper decorum and order amongst the members for systematic and smooth functioning of the club activities. However, care has to be taken that these rules and regulations are not very rigid and authoritarian in nature but are framed in a manner to facilitate its functioning. Otherwise, the whole exercise is likely to stiffle the activities of the club and take away the element of fun which is so essential for the success and continuity of such activities.

The activities and programmes of a science club need to be carefully planned keeping in view the available facilities, financial implications and above all the interests of its members. In the beginning children joining the club may not be sure of their interests and the type of activities they may get involved. It is, therefore, essential to plan some simple activities in advance for initiating the beginners. Although a science club is not a classroom, it is most likely that the members will still look to their sponsor or the teacher for guidance and help. It will also be desirable in the beginning to have an informal discussion amongst the members to broadly decide about the do's and don'ts to create proper club atmosphere. It is indeed the task of the sponsor to develop proper club atmosphere without taking recourse to authoritarian management practices. Of course, once the club is established, the efforts required in this direction would gradually decrease and the members would acquire leadership to carry out the functions of the sponsor.

Science clubs may conduct a variety of programmes and activities such as designing and conducting experiments and projects; preparing science models; working with materials like, paper, wood, glass, metals and plastics; organising guest lecture, seminars, symposium, debates, essay writing competitions, quiz competitions, science plays and science exhibitions; screening of science based video programmes and films; organising field trips and excursions and so on. A science club may offer any one or more of these activities depending upon the available resources and the interests of its members.

A scheme for the popularisation of science clubs in the country was initiated by the NCERT in 1967. Under this scheme, a number of schools were given a lump sum grant to establish science clubs. A booklet containing guidelines for organising different types of activities as well as a model constitution for science clubs was also published..Subsequently, the NCERT has also developed a science club tool kit and organised training programmes for the state level functionaries. Many other governmental and non-governmental agencies are also promoting science club movement in the country. In spite of these efforts, the science clubs in the country are yet to make their presence felt.A recently conducted survey puts the number of science clubs in the country around 4,000. Not all of them are active throughout the year. Although the number of science clubs appear to be large yet it is not significant number keeping in view the number of schools and the students population in the country. The main reason for this not so bright picture seems to be lack of motivation and interest on the part of both students and teachers. Another reason perhaps is the lack of

resources, continuous flow of ideas and guidance materials for the organisers of the science clubs. As a result, even if a science club is established it fails to retain interest of the members for a long period of time.

The science clubs need to be promoted in a big way if they are to play a meaningful role in improving the quality of science instruction in schools. This requires encouraging individual, governmental and non-governmental agencies to come forward in promoting science club activities.

Science Exhibitions

Organisations of children's science exhibitions is perhaps most popular form of out-of-school activities in science. The science exhibitions provide an important forum to the young children to display the products of out-of-school activities in science, their creative ideas and perceptions in the form of working models, investigatory projects and in a variety of other forms. Such exhibitions give them an opportunity to share their ideas and findings with their peers and adults. Needles to say that the young children love doing things and they also love showing others what they have done. It is this spirit that is abundantly reflected amongst the participants of every science exhibition. Their enthusiasm, interest and curiosity is a clear indication of how much they love to be a part of the action.

The importance of science exhibitions in learning process has been realised for a long time. Developed countries have a long tradition of organising science exhibitions involving school children. These exhibitions are regularly held at different levels — starting from school to international. Usually the first level of science exhibition begin at school which display investigatory projects, experiments, collections, scale models of gadgets and machines and sometimes even innovative devices worked-out by the students either individually or in group. These school level exhibitions provide the foundation to build up the city, district, state and national level exhibitions. The national or state level exhibitions in many countries are also a part of the chain for organising international level science exhibitions. The network of science exhibitions is, therefore, well established which gives an opportunity of participation to every school student who has an interest in such an activity

The history of science exhibition movement in our country is brief but fascinating. The first efforts in this direction began in early sixties with the organisation of science exhibitions in some states. These attempts were confined to a few states with participation limited to a selected number of schools within a state. For many reasons, this initative could not achieve necessary momentum to become a countrywide programme. The science exhibition movement received a fresh impetus in 1971 when the first national level science exhibition was jointly organised by the National Council of Educational Research and Training (NCERT) and the University Grants Commission (UGC). The first National Science Exhibition for Children conceived to be organised every year as a part of Bal Divas celebrations was held partly at Bal Bhavan and partly at the National Physical Labora-

tory, New Delhi. This exhibition was renamed in 1988 as Jawaharlal Nehru National Science Exhibition for Children (JNNSEC) on the occasion of the birth centenary of Jawaharlal Nehru whose birthday, the 14th November, is celebrated as Bal Divas every year.

The National Science Exhibition for Children has undergone many changes in its organisational set up, form and format since its inception. In the formative years, the entries for the exhibition were invited by the NCERT directly from the schools. Screening and selection of exhibits was done centrally through a panel of experts. However, soon it was realised that this process of selection does not ensure representation from all states/UTs and all types of institutions. Entries from educationally backward states and rural schools could hardly compete with relatively well off institutions from urban areas.

The situation changed with the introduction of state-level science exhibitions in 1976. The state-level exhibitions were organised by a few states in the beginning but within a period of two to three years almost all states and Union Territories had their own exhibitions. Later on the district/regional level exhibitions were introduced in the states/UTs. Thus, within a decade, the National level exhibition became a cluminating point of a three-tier exhibition system. The organisation of state level exhibitions also ensured representation of all states/U.T.s in the national level exhibition as now the selections for the latter were made from the entries received from a particular state.

The process of organising JNNSEC has been more or less institutionalised over the years. The preparations for organising the national level exhibitions start a year in advance when a decision on the main theme is taken. The theme usually focusses on a contemporary social or scientific issue. The main theme besides maintaining uniformity give an opportunity to the students to thoroughly analyse it and then work-out plausible solutions for issues and problems related to it. Thus, the theme also helps to create an awareness about the issues and problems concerning it. Once the main theme is decided a number of sub-themes centring around it are worked out at the NCERT to broaden its scope and coverage. A detailed write-up is then developed on the exhibition for the use of states. It includes the rationale for selecting the theme and guidelines for developing the exhibits. These guidelines alongwith a detailed criteria for the evaluation of exhibits is then communicated to all states, Union Territories and school systems like Kendriya Vidyalaya Sangathan, Navodaya Vidyalayas and Atomic Energy Central Schools. The school, district and state level science exhibitions are organised by respective states/UTs between September to December every year following the guidelines and the theme provided to them. Apart from academic guidance, the states are also provided with financial assistance by the NCERT to partly meet the expenditure for organising State level science exhibitions. There is intense but healthy competition among the participants at every level for selection to the next higher level. Thus, best exhibits from schools participate at the district/regional level and better ones amongst them are dis-

played at the state level. The exhibits adjudged best at state level are forwarded to the NCERT for selection for the JNNSEC to be held next year. Thus, each cycle takes two years to complete.

The venue of JNNSEC and the agencies collaborating with the NCERT in its organisation has also been changing from time to time. The exhibition was organised at Teen Murti Bhavan from 1972 to 1978, in 1980 and in 1995 in collaboration with the Jawaharlal Nehru Memorial Fund. The 1995 exhibition was also co-hosted by the Government of Delhi. In 1978, on persistent demand of the states, it was decided to organise JNNSEC in different states by rotation. Since then the exhibition has been organised in 12 states in collaboration with the respective host state.

The exhibits displayed at the JNNSEC has also undergone many changes both in terms of quality and variety. In the formative years the majority exhibits were static models or improvisation over traditional experiments. These have now been replaced to a great extent with working models reflecting innovative and creative ideas concerning the theme and the subthemes of the exhibition. Still, there is enough scope for further improvement in the quality and standard of exhibits. Lack of proper reference materials, financial resources and technical expertise are cited by the participating students and teachers as the main factors which hamper their efforts in exploring new ideas and in designing more sophisticated working models. One of the most encouraging impact of the science exhibition programme is perhaps that it has spread to remotest villages of the country. The fact that students from remote villages in almost all states participate at the national level is a testimony to such an assertion. Moreover, the participation of substantial number of rural schools from almost all states is increasing every year which too supports the view that at school, district and state level much more number of schools are participating from these areas.

The participants of JNNSEC truely represent a mini India with children speaking different languages having distinct cultures and food habits. Yet, they communicate with each other with unbelievable ease and initiate a bond of friendship within a short period of their stay. Promotion of a feeling of oneness and national integration, therefore, is an important outcome of JNNSEC.

Besides, NCERT a number of other agencies are also actively engaged in promotion of out-of-school activities through science exhibitions. The National Council of Science Museums organises four zonal science exhibitions every year. Science exhibitions are also organised by a few science clubs.

A number of programmes are also organised by various agencies for popularisation of science Every year, the National Council for Science and Technology Communication (NCSTC) organises a Childrens' Science Congress to focus on a contemporary theme. The national level meet is culmination of district and state level children's science congress. NCSTC also organises Vigyan Jathas in which a variety of programmes like exhibitions, street shows, film shows, plays on scientific themes are organised throughout the country.

There is no doubt that a significant

number of schools in the country get involved in out-of-school activities in science in one form or the other. Yet, the number of children engaged in these activities is still insignificant compared to the vast population of students in schools. If the out-of-school activities in science are to play their role envisaged in improving the quality of science education, a concerted effort has to be made to make them accessible to every child The first and the foremost requirement to accomplish this goal is to motivate and persuade the science teachers as well as those who are trained in science related professions to assume leadership role in promoting out-of-school activities in science. Simultaneously, an infra-structure to continuously generate and disseminate ideas as also for the flow of funds needs to be developed. A beginning in this direction, perhaps, could be made by pooling the resources, man-power and infrastructural facilities of all governmental and non-governmental agencies engaged in the promotion of out-of-school activities in science.

Bubbles More Bubbles

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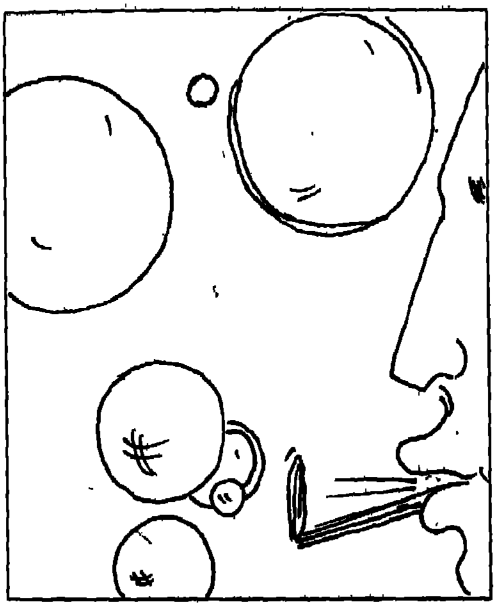

Children are born doing science. By randomly touching objects and placing things in their mouths, toddlers learn what is hot or cold, sweet or sour, sharp or dull, rough or smooth. Pre-schoolers learn almost everything scientifically—through trial and error and for older children daily life is full of scientific discovery. Children learn about the world by experimenting and observing— trying things out and watching what happens. That's science.

Experimenting with soap bubbles is one of such exciting activity which the children of all category will love to do to investigate the geometric forms of soap bubbles and the pulling force of tension in soap films. With soap bubbles one can touch the roots of geometry and experience it also. The basic idea of points, lines and planes can be visualised in three dimensions besides having an insight into the interplay of pulling force of tension information of various geometric patterns.

Concrete experiences with soap films and soap bubbles can help student bridge the physical world with the abstract. Exploring the points, lines, and surfaces of bubbles connects to their prior experiences and intuitive understandings of objects, motions and spatial relationships. Working with bubbles can extend their experiences. Manipulating geometric forms can help students think mathematically. It can become a bridge to the abstractions of geometry.

Bubbles can be found everywhere. There are bubbles in the sink when we wash the dishes and there are bubbles in the bathroom when soaps or detergents are used. Bubbles make bread light and fluffy and bubbles rise from soda to tickle your nose. But what is a bubble? A bubble is a very thin layer of liquid surrounding a volume of air. And what is so fascinating about bubbles? The spherical shape, the fragile nature, the beautiful colour or a combination of all these? Why are most bubbles round? Why not cube, tetrahedron or other geometrical figures? To understand this, we shall have to look at the forces that shape the bubble.

Surface Tension in Water

Try to fill a glass with water. Can the wa-

ter be filled above the rim of the glass? Try it. One can also float a small needle on the surface of a glass of water. Have you ever observed water striders — an insect which can skate or walk on the surface of water? All these effects are possible due to 'Stretchy Skin' effect of water called surface tension. The tension in a water surface results from the intermolecular forces of attraction among water molecules. Water molecules pull on one another in a way that enables the water to change shape easily and flow like a liquid. Within the water surface, the pull on any individual molecule is equal from all side. But at the water-air boundary (at the surface), water molecules in the outer layer are pulled only by water molecules below and next to them. There are no water molecules above them pulling upward as the air above exerts no attractive pull. This results in an inward pull and a taut surface.

The same elasticity can be witnessed in a drop of water that forms on the end of a water tap. The weight of the water pushes down, gradually changing the surface of water from flat to round. The taut surface stretches and bulges out. When the surface can no longer contain the bulge, a

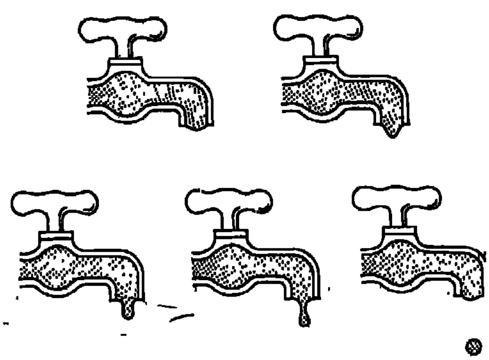

Fig. 1

round drop detaches (Fig.1). The forces of tension in the closed surface of the water drop pull it into the form of sphere. One can observe the similar effect when air is blown gently through a straw beneath the surface of water in a bowl (Fig.2a).

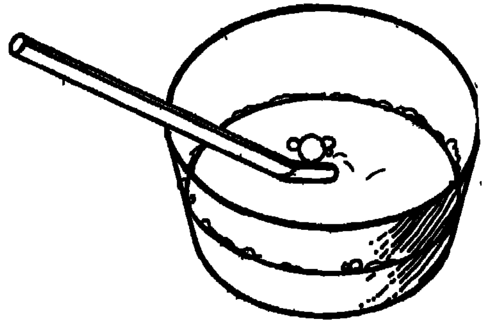

Fig. 2a

Have you ever tried to blow a bubble with pure water? Rather impossible. The surface tension in plain water is just too strong for bubbles to last for anytime. The other problem is evaporation, as the surface quickly becomes thin and the bubbles pop-up.

Surface Tension in Soapy Water

When we use soapy water, the pulling force of tension in its surface becomes noticeably weaker. One can notice that a drop of soapy water is not spherical but spread out and flat. The pulling force of tension in this case, is not strong enough to shape the drop into a sphere.

Blow air gently through a straw submerged in a bowl of soapy water. You can see bubbles, more bubbles; bubbles form atop the surface. These bubbles have the same dome shape as water

bubbles, but last much longer. The pull of tension in the soap film shapes the soap bubbles, but does not pull them apart so rapidly (Fig.2b)

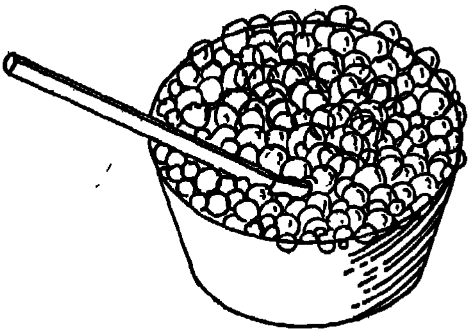

Fig. 2b

The reduced tension in a thin soap film results from the way soap molecules and water molecules attract one another and distribute themselves in layers. A soap film, either in the form of a bubble or a flat sheet is layered like a sandwich. Two layers of soap molecules sandwich a middle layer of water molecules. This structural arrangement stretches more easily than a single layer of water molecules and it pulls apart more slowly.

Take a thin wire and bend it in a closed loop. Dip it in and out of soapy water and watch the soap film that stretches across the loop. Why does'nt the soap film pull apart? The answer again is, the reduced surface tension of soap films. Again try to blow gently on the soap film and it bulges out. If you blow harder, a spherical bubble will form and float way. The tension in the soap film opposes the outward push of air. When the soap film stretches far enough around to close in on itself a bubble forms. The tension in the soap film makes the surface as small as possible a—sphere, as this is the smallest possible surface area for a volume of air it contains.

Look at some examples of solids and compare their volume to their surface area.

Shape	*No. of Sides*	*Volume (Cubic inch)*	*Surface Area (Sq. inches)*
Tetrahedron	4	1	14.7
Cube	6	1	6.00
Octhedron	8	1	5.72
Dodecahedron	12	1	5.32
Icosahedron	20	1	5.15
Sphere	Infinity	1	4.84

Notice that the sphere has the least surface area of any of the geometric solids.

A soap bubble is round for the same reason that a cat curls into a ball on a cold night. That is the shape that offers largest volume with the smallest surface area. The cat minimizes its surface area to stay warm—the less surface the cat exposes to the air, the less heat the animal loses.

Bubble Colours

Colour is one of the most fascinating aspects of soap bubbles. Colour of the soap bubbles is due to interference of light waves when reflected from the two layers (top and bottom) of the soap film as shown in Fig.3(a) and (b). When two reflections interfere constructively, they produce band of colour and when they cancel each other, that colour is substracted from the spectrum.

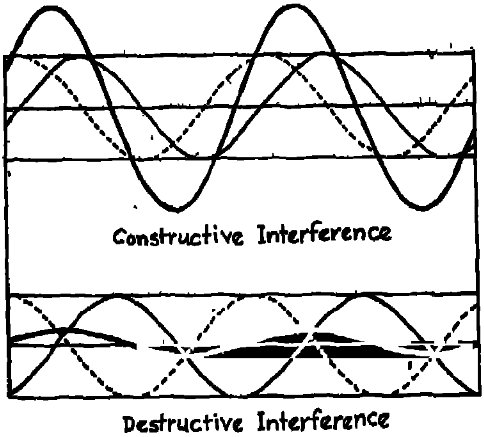

Fig. 3a *If the crests of two or more waves are in step, or almost in step, they can combine into a larger or more intense effect. If the crest of one wave meets the valley of another, they cancel each other out. When two light waves cancel each other, the result is darkness.*

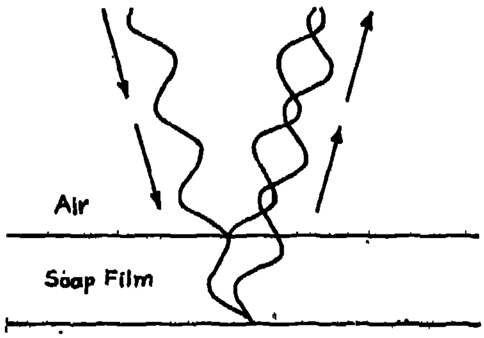

Fig. 3b *White light is separated into colours as it reflects from the two surfaces of a thin film. Where the two reflections interfere constructively, they produce a band of colour, where they cancel each other, that colour is subtracted from the spectrum.*

The thickness of the film which goes on decreasing is also responsible for various colours of the bubbles. When the bubbles becomes so thin that cancellation occurs for all wavelengths, it appears black against a black background, before finally popping up.

Geometric Forms in Bubbles and Surface Tension

The tension in surface of liquids and liquid films determine the geometric forms of soap bubbles singly and in combination. The roundness of the curved soap film that defines a soap bubble gives evidence of forces at work. The force of tension in the soap film surface opposes the expansive push of the air enclosed by the soap film. When the soap bubble is stable, neither expanding nor contracting, the forces are in balance.

When soap bubbles intersect or combine the shape changes dramatically, specific geometric form and patterns results and the total surface area shrinks. The changes give evidence of pushes and pull in the intersecting soap film surfaces.

When a single spherical bubble is blown and placed on a flat surface, it flattens and widens into a hemispherical dome. When another bubble of same size is combined with this, the shared surface is flat. If the two bubbles are of different size, the shared surface bulges into the larger bubble. One can find that the total area of three surfaces is less than the total area of the two initial bubbles. When three or more bubbles combine, a straight line and 120° angles result.

Points show up in bubble clusters wherever six surfaces intersect (Fig.4, 5, 6, 7, 8).

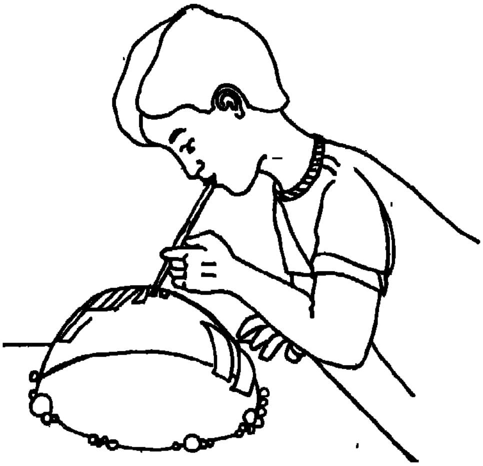

Fig. 4

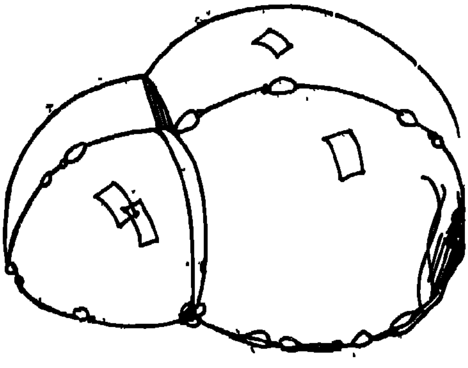

Fig. 5

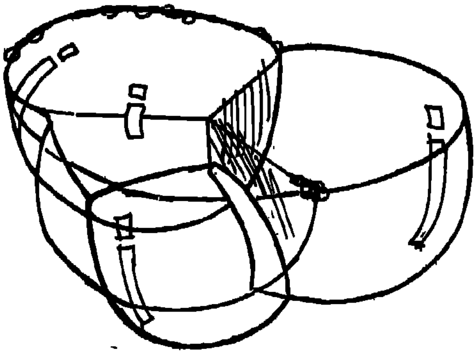

Fig. 6

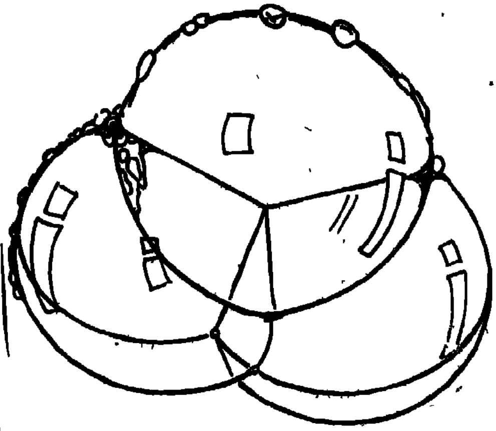

Fig. 7

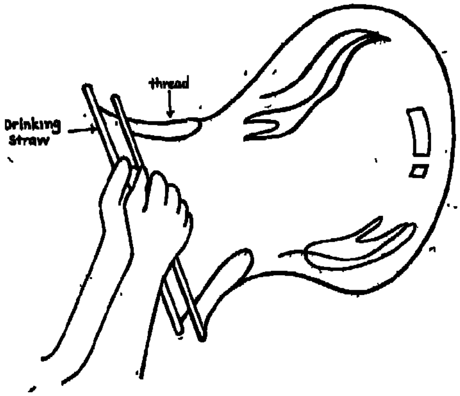

Fig. 8

Again, the forces of tension in the combining surfaces together engineer the geometric arrangement. The amount of enclosed air remains the same. Surface tension increases the number of soap film surfaces, but decreases the total surface area. The outer soap film surfaces, plus the inner shared surface, add up to the smallest total area than contain the enclosed air. Clusters of bubbles exhibit many different two-dimensional and three-dimensional shapes.

Having understood the basic features of bubbles, one can start experimenting with them using simple available materials like liquid soaps, detergents of various kinds, bubble wand, drinking straws, strings, trays, jars, bucket, filter paper etc.

The first step is to prepare good bubble solution for blowing long lasting bubbles. Liquid soaps and detergents mixed with a small amount of glycerine (to give stability to bubbles) can give really long lasting bubbles. Students can try various combinations of quantities of both to arrive at a very good recipe. Once the bubble solution is ready, the students can now make bubbles, combine bubbles, substract bubbles to create variety of forms and shapes and in the process may observe the balance of forces in action. Bubble prints can be taken by blowing a cluster of bubbles in a bowl with soap solution, adding the desired colours and then placing a filter paper on the top of the bubbles cluster. Similarly the bubble colours can be observed by blowing bubble and observing in light. The list of activities are unlimited and they only limit is the imagination, creativity and skill of the students experimenting with bubbles. All the insights on geometry, forces and structure can come to the students not by reading or watching but by doing bubble geometry themselves. Let them experience it.

Learning Through Out-of-School Activities in Science

The New Frontiers

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Learning is a complex process. It is becoming more complex as in the age of information revolution. Amount of information is being doubled every seven years. A large chunk of these information relates to science and technology, since it is the fastest growing area of knowledge. So teaching science in a useful way is a challenge faced by today's educators. This write-up attempts to address the inter-relation of learning and knowledge on the role of Out-of-School Activities(OSA) in science teaching. Some new unexplored areas of unconventional science teaching has also been highlighted.

What is learning? This seems like a simple question until you begin to think about it. When a child takes her first step or when a boy is able to fly a kite, or can multiply 8 × 9, these all are examples of learning. Learning is usually defined as a change in an individual caused by experience and education is the systematic process for learning. To make learning more meaningful and to make knowledge more useful for wholesome intellectual development, the process of education is undergoing continuous changes and upgradation since long. As a result education has developed as a specialised subject itself. Educational psychology always had two principal streams of thought. One is direct education which focuses primarily on the formal methods of education in increasing the student's knowledge and skills. The other focuses on effective outcome of schooling, by taking education out of classroom by enhancing creativity and human potential. Though direct education still widely practised as principal mode of education, humanistic education or open school learning is gradually gaining ground as more effective methods for inculcating through knowledge back by intellectual values and creativity. Primarily goal of humanistic education is to teach the students how to learn and how to make students to value learning for its own sake. It allows the students an opportunity to locate information on their own, at their will. It has been observed that open, out of school activities induces better learning in certain cases. Particularly in case of science teaching where hands on experience or demonstration with practical models and examples is a necessity, OSA is found to be more effective. In an increasingly technically-advanced civilization in which we are living today, science learn-

ing is having utmost importance and priority. So teaching science through out-of-school activity is now considered one of the most effective methods for not only inducing scientific knowledge but also in creating a rational and logical attitude towards life. It also helps a student to learn through playful activities rather than to learn out of competition. Let us examine why out of school learning in certain areas of science education has scored over traditional system of formal learning. Though it is found that the direct education method is more effective in structured learning process as it has a method of performance appraisal, though it does not really help to be creative and innovative. To clearly understand the merits and demerits of the two systems we must understand the different stages involved in a learning process. In 1974 Robert Gagne has proposed a series of 8 conditions which must be satisfied if effective learning is to take place (See Fig.1).

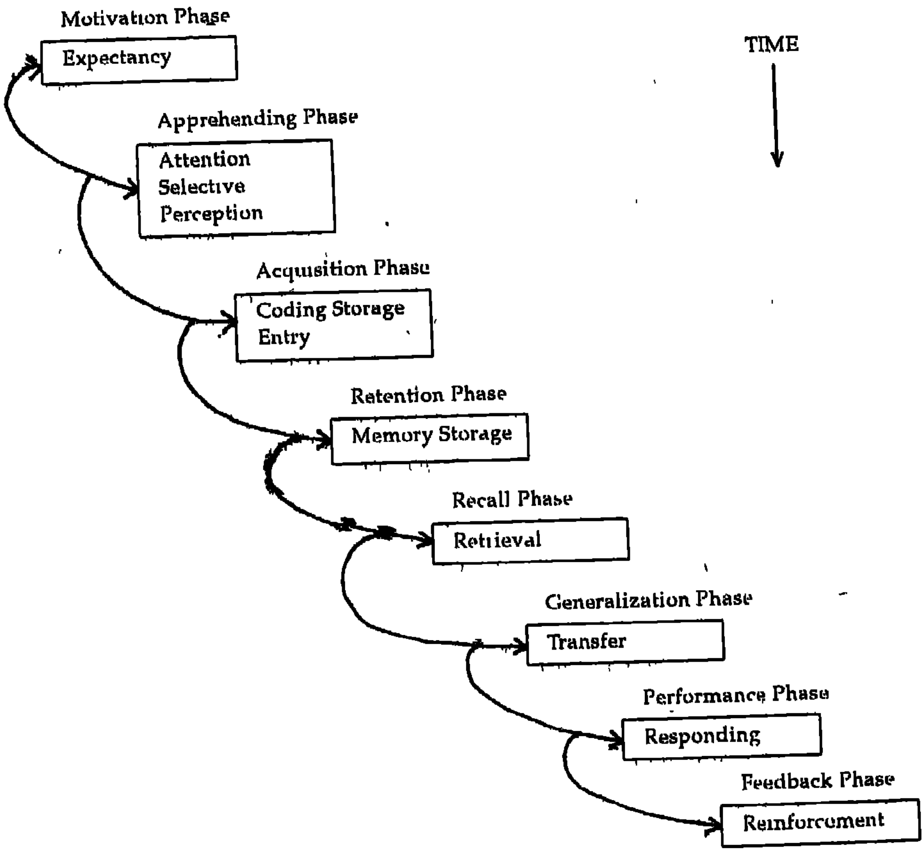

Fig. 1 *Different Phases of Learning*

1. *Motivation Phase* : The learner must be motivated to learn by an expectation that learning will be rewarding. For example learners might expect that the information will satisfy their curiosity about a subject, will be useful to them, or will help them get a better grade or will put him ahead of the others.

2. *Apprehending Phase* : The learner must attend to the essential features of an instructional event if learning is to take place. For instance, this could mean paying attention to the relevant aspects of what a lecturer is saying or to the main ideas in a textbook. The lecturer can focus learners' attention on important information by saying (for example): "Listen to the next two words I say", or "Look at the upper part of this picture". Written materials can do the same by highlighting certain words or sentences, or by using headings, chapter outlines, and notes in the margins.

3. *Acquisition Phase* : When the learner is attending to relevant information, the stage is set. The information is presented. However, information is not stored directly in memory. Rather, it is transformed into a meaningful form that relates to information already in the learner's memory. Learners may form mental images of the information or form association between the new information and old information.

4. *Retention Phase* ; The newly acquired information must be transferred from short-term to long-term memory. This may take place by means of rehearsal, practice, elaboration, or other means.

5. *Recall Phase* : It is possible that we can lose access to information in long-term memory. Thus an important part of learning is to learn to gain access to that which we have learned, to recall previously learned information. Access to information is aided by organization: well-organised material grounded by categories or concepts can be more easily recalled than randomly presented material. Recall can also be aided by noting linkages between concepts, particularly between new information and prior knowledge.

6. *Generalization Phase* : Usually information is of little value unless it can be applied outside of the context in which it was learned. Thus generalization or transfer of information to new situations is a critical phase in learning. Transfer can be aided by requiring learners to use information in new setting or circumstances, such as asking students to use new arithmetic skills to solve realistic problems, and stating "working rules" ("The angle of incidence equals the angle of reflection") that will apply in many circumstances.

7. *Performance Phase* : Learners must demonstrate that they "have it" by some overt performance. For example, students who had just learned subject-verb agreement may show their new knowledge by choosing the correct verb in a sentence.

8. *Feedback Phase* : Students must receive feedback on their performance indicating whether or not they have understood. This feedback may serve as a reinforcer for successful performance. For example, students in an automobile mechanics course might watch someone assemble a carburetor themselves and install it in a car (performance phase) and then see if the car starts (Feedback

phase). If it does, they are reinforced for their learning behaviours. If not this is a valuable information they will use to alter their behaviour, reassemble the carburetor, and try again.

Now let us see how OSA influence every aspect of the learning process. In the first motivation phase out-of-school learning scores over classroom learning because it brings the students out of the monotony of classroom teaching and allows a more democratic atmosphere with much more freedom. In apprehending phase and acquisition phase direct education is found to be slightly better because information is presented in a more classified and organized form but in retention phase and recall phase out-of-classroom method is found to be better than direct method. This is because the out-of-school activities are experience-oriented rather than information oriented. Students gather information through experience and retention is much higher due to active involvement in the process. During the recall phase later on they can mentally visualize the process and sign it easier to recall. In generalization phase or transfer of information to new situation which is considered very critical phase of learning they find it more handy. They find their activities based on experience to be more handy for generalization on performance phase. It is easier for students to perform according to the newly acquired knowledge because they can corelate the new situation of the new set-up of conditions with their past similar experience in the feedback phase also. Out-of-school activity makes them better equipped to get the desired feedback and in case of failure they are more motivated to try again since they have already done similar things during their activities. However out-of-school activity does not in any way limit the credibility of direct education since direct education in structured form has its own role to play in the whole process of education.

It is a well established fact that out-of-school activity in science has a distinct role to play in science education. Unfortunately OSA in science are very much neglected in our country, though in developed countries the importance of OSA has been recognized and is given due care. In our existing system of education science teaching is still confined within chalk and black-board. This formal system of education is failing to put stress on creativity and freedom in the thinking process, and whereby the final outcome is languishing in mediocrity. However, of late an awareness is gradually dawning upon, to create more opportunities for out-of-school activity based learning in science. But unfortunately only a very few schools have the resources and infrastructure to carry out OSA. The following are the major hurdles in carrying out OSA in science in the existing system :

1. Very few schools are having enough financial resources to carry out OSA.
2. Motivation for OSA is limited because it has got no place in the existing syllabus and no extra credit is given for it.
3. Teachers are having very less exposure in OSA and they are seldom encouraged by the authorities to initiate something.
4. Absence of resource materials like models, low cost hands on exhibit and

kits etc., also poses problems.

5. The syllabus is so heavy that there is very little scope within the school curriculum to undertake OSA.
6. Another major factor is lack of awareness that OSA sometimes work better than formal methods of teaching science subject.

However in recent past certain government and semi government educational organisations and bodies like NCERT, NCSTC or National Council of Science Museum have played an important role in bringing out innovative OSA for supplementing school science education. They are also doing conscious effort to encourage the schools to have OSA. The result in some cases are very encouraging. Some unconventional OSA which has been tried and found to be effective are given below:

1. *Science Magic Show* : We know that magic shows are always favourite with children. Magic is of two types - one is based on hand-tricks and another is based on science and human psychology. For this show the second type of magic is chosen and shown before a group of students by the resource person. The apparent impossibility of the magic enlivens their curiosity. The resource person then explains the magic and the scientific principle behind it. He also encourages them in turn to learn the magic and show it before the others in similar way. It is found to be immensely popular form of science education.

2. *Science Experiment Competition* : Here the class is divided into different groups, each comprising two or three students. They are asked to show one science experiment based on any science subject before the others. The criteria of excellence is the most innovative, educative and eye catching experiments. They are given specific time of two-three days to think and arrange for necessary ingredients for showing the experiments. Token reward is given for the best performance. This motivates them to go through different readings to do interesting experiments in order to select the best for themselves and thereby broadening the knowledge.

3. *Find out a Science Object* : Here a group of students is taken to a place for excursion where all the individual students have been told to find out an object which is having some scientific significance. They are given stipulated time for this. The object may be a rare plant or a peculiar piece of pebble, some piece of metal or may be a mushroom. Once the time is over they are asked to show their object one by one and say a few words about its scientific significance.

4. *Identify Leaves* : A set of 15 or 20 leaves of different plants are given to the students enclosed in an envelop. Then they are told to identify the leaves with their respective plants and write them on a piece of paper. If somebody can write the botanical names also he will be given extra weightage. Similar plays can be designed with stones, chemicals used in everyday life, minerals, etc.

5. *Science News Writing Contest* : Students are asked to go through newspapers, science magazines, T.V. news etc. for two-three days to present the most existing science news that they have come across. They will have to write it

in the form of news, citing the resources for authenticity.

6. *Science Fiction Writing* : Here the students are divided in groups, each comprising 4 to 5 students. They are given some interesting topics like a colony in moon, a voyage to mars or encounter with an alien spaceship. Now each group is asked to apply their imagination and build up a story which will have some interesting fiction element.

The above-mentioned activities are only a few examples and representative of the vast scope i.e. there are far more such imaginative activities which we may have to inculcate scientific temperament besides strong knowledge-base in science. There is every reason to be hopeful that OSA will gradually take a prominent role in the field of Science Education in our country in future.

Some Out-of-School Activities in Science and a Few Related Issues

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Bhopal

The schooling age in India starts at five-plus and under normal circumstances continues upto around seventeen years of age. On an average, six hours daily, a boy or a girl is expected to spend in a school. Multiplying that by 200 (which is the average number of days in a year a school remains open for teaching and curricular activities), one gets a total of 1,44,000 or 0.15 million hours roughly, when a student is compelled to interact in a formal teaching environment of an Indian school.

While 0.15 million hours in twelve years or six hours a day is in itself, a considerable amount of time for a young person; adding to that another 3 hours for preparation and homework leaving aside 10 hours for sleep and maintenance, one can easily conclude that it will require a supernatural effort for an average boy or a girl to do something creative outside the scope of his or her school. The debate that naturally emerges therefore is whether the teaching hours should be reduced and the homework and preparation at home for the next day's class should be altogether eliminated.

We shall leave these issues for the time being and try to define what under the circumstances is meant by out-of-school activity. If a girl comes back home and learns how to cook *Sambhar* (a South Indian delicacy) or if a boy reads Tin-Tin comics during his leisure, can this be called an out-of-school activity? Or for that matter, when one goes to the playground to take part in some outdoor group game or joins a science club for making models, is he or she by definition, involved in an out-of-school activity? The answer to this is both yes and no. Yes, because the activity is creative and is likely to add another dimension to the personality of a person. No, because under the constraints of time put by the system one can at best pursue it as a small time recreation and nothing more than that. For one who is

not serious can never be creative in an activity. Not only does there exist a need for a formal training but also one should be granted enough opportunity in terms of time for achieving some standard in a particular activity.

We may therefore define an out-of-school activity as the one which is essentially extra curricular in nature formally speaking, but for which time should be extracted from the six-hours-a-day schedule of the school. Naturally the schools have to be geared up to arrange for the necessary infrastructural facilities for its students to pursue an out-of-school activity. The apparent dichotomy in this definition would fade away when one critically performs the 'goodness of fit' test (as in a typically engineering problem) with the out-of-school-activity and the given time-frame in the light of our analysis.

A Flow Chart

The flow chart given below describes a typical out-of-school activity. It is clear from Fig.1 that formal training and feedback process are both important for the activity to achieve its creative-best standard. An assessment in the form of

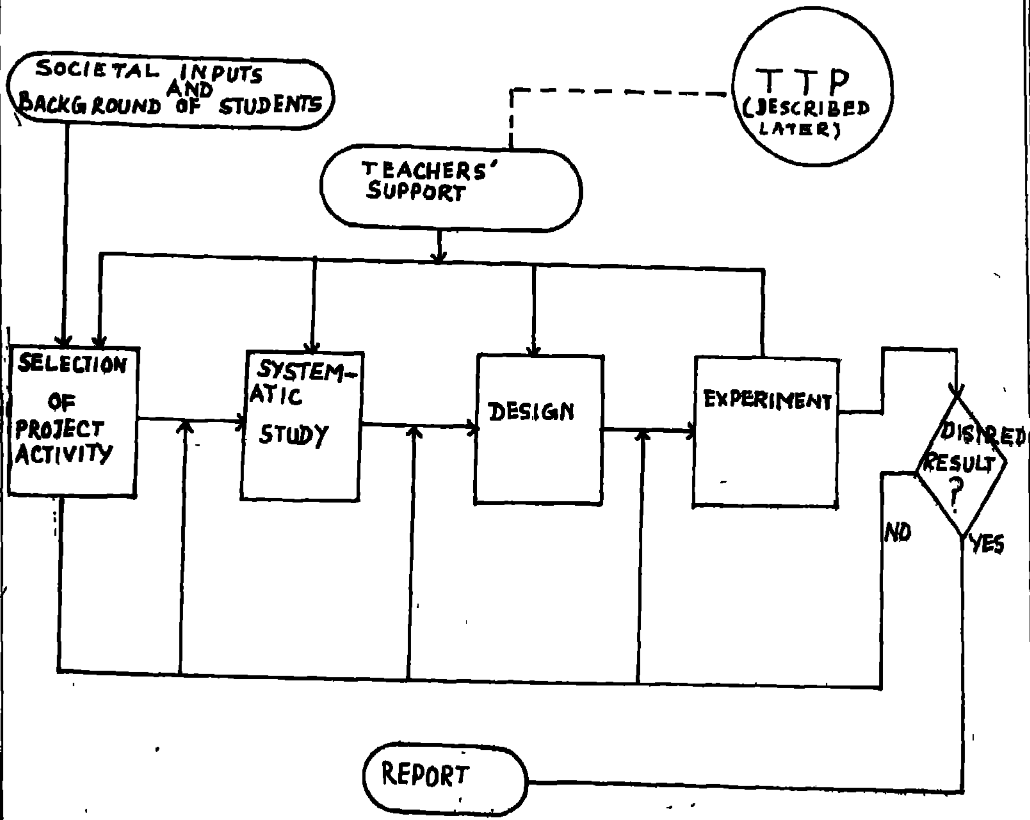

Fig. 1 Flow Chart

demonstration/formal competition/display not only evaluates the activities but also inculcates the urge in the student to surge ahead.

The formal training could be in the form of lecture cum demonstration. In most of the activities (we shall describe after this) practical demonstration has tremendous importance. It is at this stage that the situation in the typical Indian context is not very encouraging. Leaving about 10 per cent schools most of the others do not even have a proper school building or a playground. Needless to mention a well-equipped hobby centre, a library or a laboratory is a far cry. Careful planning of the activity, therefore, is required which will suit the conditions and need minimal or zero help in the form of infrastructure facilities. This is where experience, interest and ability of a team which includes the Principal, specialised teachers and interested students are a must.

The feedback process also forms some sort of internal assessment or evaluation but apart from that a formal evaluation is also necessary to fire the competitive spirit in the young mind as stated already.

Some Activities for Rural Schools

Vermiculture

All yor require for this activity is a space of about 15′x 15′ preferably in an agricultural land and some regular flow of garbage and kitchen waste. This activity will be more effective in areas which experiences good amount of rainfalls.

The space indicated above could be within the school premises or even outside if the conditions permit. It is needed to dig out the loose earth and make a pit of the aforesaid size which will be about 5′ deep. Skins of vegetables, green leaves and kitchen waste can be found in plenty in a village. Process can be explained by the Science/ Bio-Science teacher so that the role of the earthworms are well appreciated by the students. The advantage of this activity is that it is both creative as well as productive.

Nature Camp

This activity can be extremely enjoyable and informative at the same time. Also the importance of this cannot be overestimated particularly in the light of the fact that life science area is largely neglected in practical classes in most of the schools because of difficulty in availing living species.

Vacation is the ideal time for conducting a nature camp. A group of children, preferably above Class VII, accompanied by one of the teachers may go to a nice place and study the flora and fauna of the area. Specific projects or extensive studies of a particular species can also be offered to an advanced learner.

Sky Observation

This is yet another activity which required very little or almost no equipment while it can be extremely informative. A small 3" telescope and a binocular are required for conducting this activity. The charts, details of various stars and planets and their positions can be found in the local and national dailies which are regularly published in them. Otherwise the same can be obtained from the Positional Astronomy Centre, a

government institution which circulates these details on demand[1].

Telescope making, which is a related activity is described later in this article.

Sky observation is an activity which paves the foundation of understanding astronomy and astrophysics. Observing the night sky regularly can help in understanding the subject in clearer ways. Important astronomical events like arrival of a comet, solar eclipse, lunar eclipse, clashing of a comet on a planet can arise additional interest.

Pet Club

This is relatively a new concept which has been experimented with at the different centres under the National Council of Science Museums which is the apex body of science centres in the country. The result is quite encouraging[2].

For this, however, a school requires a small animal corner to house birds, rabbits, guinea pigs and albino mice, tortoises etc.

A particular bird or an animal may be given to a student who can take it home and keep it for a period, say 15 days. During this time the student will be observing the behaviour, food habits, habitations and physical characteristics of the bird or animal. He may also be given a questionnaire or some such material, to record his observations. After 15 days or so, the student should return the species for others to take them and so on.

Telescope Making

This activity and sky observation are related to each other. However unlike sky observation, one requires a moderate workshop facility for glass grinding and sheet metal work for this activity.

One can start with designing and fabrication of simple reflecting telescopes. More complex designs can be taken-up if facilities exist and depending on the interest of the students[3].

Some Activities Suitable for Schools Located in Towns and Big Cities

Model Making

This activity can cover a very wide range of subjects and can be beneficial for the school as well. The system of teaching science in our school have one big drawback. The demonstration aspect is largely neglected because of lack of funds and equipments available. Most of the explanations of scientific principles therefore are done in a classroom by lecture-method without actually showing the set-up in three dimension. Model making can improve this situation. The areas of physical science particularly can be largely benefited if this is done systematically and with proper planning. Every year 5 or 6 models on different themes from physics and chemistry or other subjects can be selected and the students can be guided to fabricate them. The best models can be awarded and kept in the school. Slowly, over a period of time, a model bank can be made in this way which will help teaching science in an interactive way.

Models need not always be made from themes found in books or syllabus. There can be small items of daily use like burglar's alarm, door bell, fire alarm, praxinoscope, periscope etc. This helps students to handle small machines and get familiarised with them.

Kit Development

This is related to model making in the sense that they use similar tools and workshop facilities and can be from a wide number of subjects. The difference is that while models are mainly used for explaining science and supplement the theoretical description in books, kits are to be used as toys for playing. They are mostly easily understandable games which can be played indoor at ones leisure. An example is Brahma's disc. Here, as we have shown in the description in Fig. 2, there are 3 cylindrical rods fixed on a wooden platform. There are 5 discs

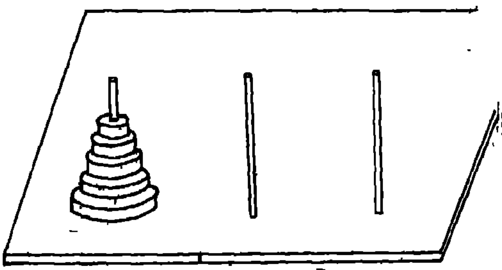

Fig. 2 *Brahma's Disc*

of different diameters but having concentric holes. The discs are originally to be arranged one above the other in such a way that no disc of bigger diameter is ever placed above a disc of smaller diameter. The task is to remove the discs by picking one at a time from one cylindrical rod and place them in the same arrangement (disc of bigger diameter will never be above the disc of smaller diameter) on another cylindrical rod. The challenge is to arrange them by the smallest number of moves. The task is not as easy as it may appear from this description.

The kit gets it name from the myth that Lord Brahma does the same job continuously but with 64 discs instead of 5. The time He takes to complete the task once is the measure of 1 second in Brahma's scale.

Amateur Radio

This has two parts. In the first part the students are taught the Morse Code for codification of the message to be sent using a telegraphic sender machine. In the second part, training is given on using a transmitter for sending message as well as receiving, with the help of a receiver set. After completion of the training the student is given licence for communicating with different HAM centres in and around the world. While this is a tremendously enjoying experience, it also broadens the knowledge of different parts of the world and increases the feeling of international brotherhood.

Towards School Science Centre

Science has become a part and parcel of modern society. It has entered into the fabric of our community life. Knowledge of science having relevance to daily practice must therefore be brought within the reach of every citizen. They shall be guided to explain their daily happenings in terms of science and not by superstitions and prejudices. They shall be made to realise that so called taboos have no value in their life and it is application of science that can help solving many problems which they face very often. What is therefore needed is organisation of sustained science programmes for the students as well as the community people so as to make them understand the values of science and overcome the barriers of social prohi-

bition and restriction which result from convention and tradition. Many social and voluntary organisations are active in the field. Schools too have to be oriented to provide well planned and well organised programmes for catering to the needs of the students.

Perfect understanding of science always demands direct involvement in some kind of practical work, in addition to theoretical knowledge gained through reading and attending lecturers. Only book-study cannot shape a man to be a scientist or an engineer, any more than it can teach him to be a farmer. Even for a little knowledge of science to be complete in itself, the learners must have access to objects with which scientific knowledge begins. The practical work generates opportunity for comparative application of science to the examinations and experiments with objects. It thus results in the full appreciation of the properties of such objects and the concept that such experimentation intend to develop. Schools may be the ideal place for catering this method of learning-by-doing through establishment of creative activity centres on science. This ultimately paves the foundation of a new concept of school science centre being considered by most thinkers and educationists today, as the most effective method of learning science by doing[4].

A science centre is the forum which provides facility for practising activity based learning process and to inculcate a spirit of enquiry. It fosters creative talent and generates scientific temper to build-up self-reliant culture in the community as a whole. It is characterised by two-prong channel of communication —exhibits and activities. The exhibits are interactive and participatory and intend to kindle fire of imagination in a young mind. They encompass a wide variety of subjects such as physical, applied, industrial and social science, energy, environment, crafts, industries and such other areas that are broadly linked with science to fulfil the requirement of a wide spectrum of population. Activities include demonstration and training programmes, temporary and mobile exhibition, audio visual communication and similar sort of exposure-oriented programmes. The activities are oriented towards the school system as well as the community.

A school science centre however is basically a programme and activity— oriented permanent set-up in school. It provides a forum for building up resource material through joint ventures of students and teachers and for installing a spirit of service before self, while disseminating science indirectly to the community surrounding the school. This will be able to build-up momentum for generating a new spirit and activity through the combined effort of the teachers and students. A school science centres set-up in a particular school, will become a source of inspiration to the other schools in the area. As any form of science or practising science cannot and should not be totally away from the societal influence, school science centres also cannot ignore or neglect the society. It also has a role in paying its debts back to the society. A school science centre therefore has two-prong programmes—school science programme and community science programme. The school science programme envisages to improve the quality of science education in schools by application of demonstration method of teaching and promote scientific attitude in students. The community sci-

ence programmes are intended towards awareness of science and understanding. It is generally advantageous to the rural community and help them apply the methods of science in their daily happening so that they become free from the rigorisities that they face, being captive by the traditional taboos. The objectives of the school science centre can therefore be summerised as :

To nurture creative talents among young people.

To inculcate spirit of scientific enquiry.

To generate scope for activity based learning.

To develop kits/teaching aids for their use in school science teaching and to improve the quality of school science education.

To provide training and exhibition facilities for creative work to neighbouring schools.

To educate the community as a whole in the areas of energy conservation, ecology and environment, health and hygiene, food and nutrition, implementation of improved methods to boost up yields in the field and farm, water management to eliminate superstitions and prejudices etc.

To provide vocational and career guides to the people in general in the areas of science and technology.

To create scientific temper in the society[4].

Training for the Teachers

Having spoken about the out-of-school creative activity and its projection towards formation of school science centre, we have indirectly emphasised the need for training of the teachers in this direction. In fact science demonstration lecture, creative activity and teachers training programme are three ends of a triangle. Presented in terms of vectors, teachers training programme and science demonstration lecture should add-up to creative activity[5].

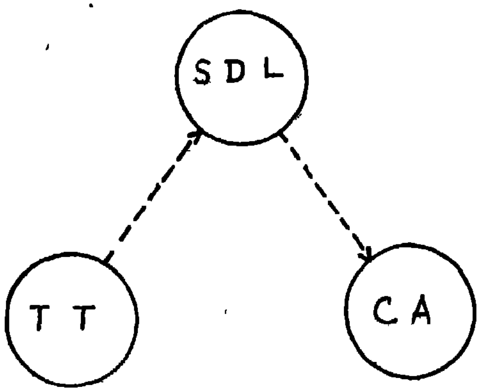

Fig. 3 Teachers' Training (TT), Science Demonstration Lecture (SDL) and Creative Activity (CA)

Teachers training shall be with an intention to familiarise them with the tools which are to be used for developing experimental set-up and also to give them a broad outline on the projects to be taken up. Subsequently the teachers themselves shall develop new projects and programmes and the activity. These three programmes together form an integral educational programme which aims at not only providing the quality science education in schools, but also develop the creative faculty of students. An introduction course of the teachers' training programme should be organised with a view to train school teachers in fabricating simple teaching kits and aids using common tools. Teachers should also be trained to develop suitable pre-

sentation techniques. There may be advanced course in aiming at developing the creative faculties of teachers in involving new concepts on kits.

Thus trained teachers can independently take-up the charge of running creative activities in their schools with the help of students who can conduct their own experiments, specific or casual and come out with innovative, novel models of their own.

Out-of-School Activities vs. Curricular Activities

We started this article with a rough estimate of the time available to a student to take up creative activity. The motto of our schools is an all round development of each student's personality, which includes sound health, scientific method of study, development of healthy hobbies enabling young people to satisfactorily discharge his debt to his family, teachers and the country. Every student under the guidance of his parents and teachers will plan in a systematic way within a predetermined time-frame, the programmes of action to implement it and to maintain the record of his programmes and conscience. One definite programme fosters the efforts and become a motivating force for further progress.

From the above, it is apparent that the out-of-school activity cannot be an altogether disjointed set from the curricular activities, at least from the point of view of time sharing. The schools and the authorities in the education department need to review the situation in the true spirit therefore.

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The Role of Science Centres in Out-of-School Activities

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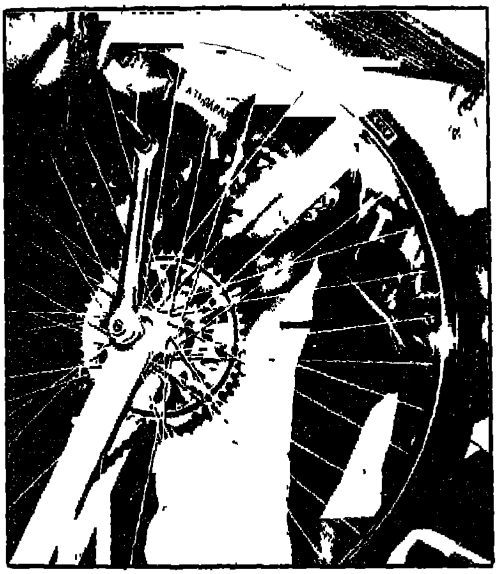

To popularise the science is the main aim of all science centres/ museums. While doing this, many educational activities are conducted inside and outside museums.

Mobile Science Exhibition

Mobile science exhibition is one of the most important activity of the science centre. Even though it is organised inside the school premises, it is definitely an outside school activity. Twenty-four exhibits, on a particular theme, are mounted inside the bus and students have to see the exhibition by walking around and inside the bus. To simplify the process of perception, 24 volunteers of the host school are trained and then they in turn explain the exhibits to the visitors. These volunteers enjoy this opportunity nicely, and they get the maximum benefit. Every volunteer comes across with about two to three thousand visitors in three days in two stages (i) The volunteer explains the exhibits just after the training is over, and (ii) the volunteer explains the exhibits just before the closure of the exhibition on the third day. It is observed that during the first stage the volunteers is much shy, hesitant and also shows less confidence in speech. But slowly the volunteer picks up, gains courage and finally in the second stage, it is found that s/he is perfect. It is also observed that a student who never utters a single word in class, speaks fluently in just three days during the exhibition. Other visitors find the exhibition much more interesting and they watch it enthusiastically. Most of the children look much happy to see the big van like, state transport bus coming in the school. Everybody rushes towards the bus and try to peep into find out what does the bus contain. As soon as the exhibition starts many of them come with pen and paper to note down about the exhibits. Many of them ask lot of questions regarding the exhibition. All three days it is a *Science Fair* and children enjoy and learn the topic. During three days' halt in school campus,

along with the exhibition, some more educational activities are also conducted to motivate the student, teachers and parents to think about science. Anti-superstition programme is the best popular activity. The children watch the experiments eagerly: to take out bhasma from hand, to pierce a hole in the skin by needle, to observe a hole in palm, to watch the water coming from an empty pot, to watch the fire formed by adding water like liquid in a pot and by watching many other experiments they remain enchanted. They try to give the reasoning to miracle. After getting it confirmed, they decide to think scientifically on a matter they see.

Sky Watching

Another activity is sky watching. They have heard about certain stars, planets but no one knows how to identify pole star from *saptarishi* or how to distinguish a star or a planet. When called many of them come with lot of questions. How earth can remain in space without support is the general question. They learn that Pole Star is stationary and all other stars are not stationary. But when observed in sky they found that at any particular time all the stars are stationary and no one moves. Can all be the pole stars? During discussion they get the answers to all their questions. Science film show is another popular activity among the children. Most of them like watching wildlife films than study films.

Mobile science exhibition thus becomes the topic of discussion all over the village. When we go for a walk in a village, most of the students point towards us telling their friends "oh, look, science people". The exhibition helps in creating a motivation in science.

In one of the schools it happened that there was an elocution competition on the topic "our friends—trees". Many children took part in competition and delivered their speech nicely. That school had its own land of about 5 acres. There was also a well in the premises. Only two or three trees were there and all other land was looking like desert. After the competition, I asked the students whether it is good to talk without any action? In further discussion it was decided to plant tree saplings next day morning. To my surprise, many children participated in the plantation programme and some of them brought garden implements, others brought saplings. It was going on for about 4 hours. That day they planted 120 tree saplings. Then in the afternoon, I asked them to form groups so that each group of 5 students will take care of one tree. This system is still going on.

I have an important observation in one of the other schools. It may need further experimentation. It happened that we had a get-together with some teachers in the school. The chairman of the school had also come. We all were sitting on chairs in a lawn in front of the school. Within next few minutes I found that everybody is moving his hands and even legs. This is because of mosquitoes. But the chairman was stationary. I was surprised to observe that the mosquitoes were not biting the Chairman, after some time the chairman went out. Then I sat on his chair. And I found that there were no mosquitoes. Why? I searched. I could guess that the only difference was that the chairman's

chair was just near to a pasijatak tree and other chairs were a bit away. This implies that pasijatak smell is mosquito repellant . Well this may need more experimentation as I said earlier.

Other Activities

Another activity is *Bunny Rabbit Club*. The rabbits— a pair— are given to children for taking to their homes. It is expected that they should take care of them, feed them and observe their habits.

Nature Club helps the children for finding out mysteries of nature. At least the children get acquainted with some of the trees. Their growth rate, flowering season, shape, root system, fruits and much more information regarding plants could be perceived through experience. Initially, a child does most of the work mechanically. But then as the time passes, he does it with much love and care. In one incident it happened that I asked a student to put some plants in a polythene bag and a 9" stick of hibiscus was put in it. He did it mechanically. He then watered it every day for about 6 days. On the 7th day he came hurriedly to me and asked me to follow him. He took me near to that polythene bag where a hibiscus stick was put in and showed a tiny green shoot which had grown on that stick. He was very happy to see it. After few days the hibiscus had grown nicely. An unknown relation has got developed between that child and the plant. He was taking care like a mother. One day he told me that now he could understand, why Jagdish Chander Bose had said "the trees do have emotions".

In our *science park* there is a big dome. There are various types of birds in it. The most attractive are the white geese. One day, just to experiment with, I kept the door of the dome wide open and with great difficulty I made all four of the white geese to come out of the dome. They were afraid and were hesitating to come out.I carried them all over the garden, kept them out for about an hour and then again back in the dome. I continued this for two-three days. Then afterwards I never had any trouble. They would come out of the dome for their routine walk. They would roam in garden, eat grass, dance and after one hour they returned to the dome. It is altogether different pleasure to be with them and observe their movements.

As far as pollution is concerned, it has become essential to plant new trees and take care of the planted trees. For this it is necessary to make each and every child familiar with plantation work. To make it a mass movement, it is required to involve school children. To some extent we are doing it since seven years. We have a well-developed garden in about 10 acres of land. A large number of trees, herbs, shrubs, creepers etc. are planted systematically. Every year two to three times, a nature club activity is organised for high school as well as for D.Ed. students. It is about 10 to 15 days programme. Children work in the garden for about two hours every day. In one batch about 20-25 students participate. All garden implements and other required materials are provided by our centre. A group of four students work together on a particular job. Some are engaged in watering, others in deweeding, some in multicating

the plants by various methods. Every student enjoys this out-of- school activity.

A *school science club* can do many things. Frequent visits to science centre can yield a lot. Instead of having one big science club in a school, it is always better to have small groups consisting of 5 students each so that they can go to a particular place and observe the things nicely. The places of visits can be (i) Railway stations (ii) Hospitals (iii) Science centre (iv) Telegraph Office (v) University (vi) Computer centres (vii) Gardens(viii) A workshop (ix) Automobile garage (x) Vegetable market (xi) Nursery (xii) Medical shop (xiii) Bridge work (xiv) Levelling of land (xv) New road construction work (xvi) Airport (xvii) Weather stations (xviii) Nala site—where micro-organisms live (xix) Museums (xx) Old forts and monuments and many more places from where they can gain knowledge. Visiting such type of places on their own, an appetite for new creations gets developed. Curiosity, courage increases, scientific principles automatically get inculcated in the minds of students. We also celebrate various days like (i) National Science Day, (ii) World Environment Day, (iii) International Museum Day (iv) Centre's Anniversary Day. During the celebrations various educational activities are organised, e.g. Popular Science Lecture on relevant topics, elocution competitions, open house science quiz contest, painting competition etc.

Annual *science quiz contest* is one of the main activities that goes on round the year. About 50 to 60 schools participate in the activity. Every school send two students. In one game there are four schools. Forty questions are asked during each game (i.e., 10 questions to each team). Questions are selected from the school syllabus. Two separate contests are organised for high school and middle school. The first game is held some time in September and the finals are held in February. Attractive prizes are given to the winners. There is very good response from schools and also from students every year.

Computer awareness programme also goes on all over the year. Eight to ten students participate in one batch. Primary knowledge about computer is given to students. Each programme goes on for about 15 days. On first day a student enters in computer room with some sort of fear in his mind and on the last day he goes out with the terms — basic, software, hardware, MS DOS version and many others on his tongue. It is not like this that the students get complete knowledge about computer in 15 days but at least they get acquainted with computer.

Popular science lecturer is again one of the best activities for students. Every month we organise one/two such lectures. Eminent educationists, scientists, professors, doctors, engineers are invited to deliver a lecture on topics of student interest. About 150 to 170 students attend the lecture each time. They get much information about the topics concerned. After the lecture, students ask various questions.

We also organise teacher training programme, vacation creative ability programme during summer and Diwali vacations.In the teacher training programme about 20 teacher trainees participate . The programme lasts for 10 days. During this time they get ac-

quainted with the workshop tools. Ten different projects are fabricated by the teachers in workshop. Many students participate during vacation creative ability programme in Diwali and summer holidays, to perform certain experiments in physics, chemistry and biology.

Life science corner in the centre, also fetches the attention of the students. There are aquariums containing coloured fishes. Asimolariums contain crab, lizard, grasshopper, love birds, white rat, guinea pigs etc. Incubator kept in the life science corner also attracts students. A team of students watches the development regularly. They are curious to observe a chick emerging our of an egg. The eggs are brought from the local incubation centre. They are kept in the incubator for 18 days. Required temperature and humidity is maintained. On the 19th day eggs are shifted to the hatchery. On 21s day chicks emerge out. They also help in taking care of chicks.

There are also exhibits on various topics. Most of the exhibits are participatory. They learn the things through fun Even the layman who visit the centre, can understand certain scientific principles by operating the exhibits.

Thus the science centre plays a very important role in out-of- school activities for the students .

Chariot to the Planets

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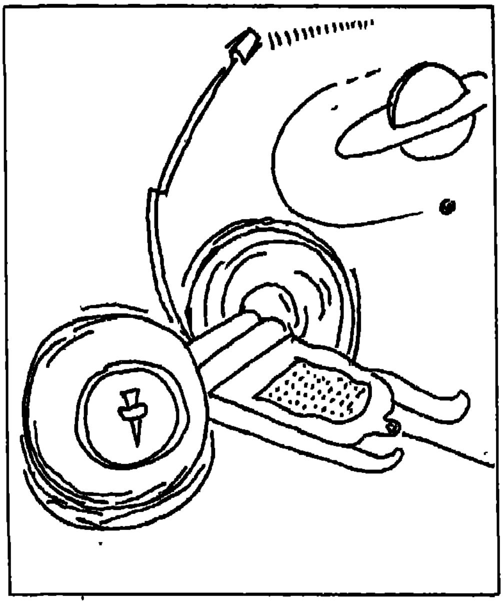

It has been the age old dream of man to get out of Mother Earth and visit the planets, which he could see only as bright objects in the night sky. In recent decades, this dream is being gradually realised, thanks to a powerful tool that Science has placed in our hands, the ROCKET. Apart from interplanetary travel, the rocket has also led to revolutionary changes in communications and weather forecasting. The earth satellites which make it possible for us to talk through the phone to a loved one half a world away, which enable us to watch TV programmes beamed from far-away lands and which watch the weather and landscape for us from high above with unblinking eyes, were all lifted from the earth and placed in their orbits by giant rockets.

Rockets are powerful weapons of war too. Intercontinental Ballistic Missiles (ICBM), which are basically guided rockets, can carry and deliver nuclear bombs over thousands of kilometre and are very difficult to counter. But in a way, they have also served a useful purpose in that they have made all-out wars between major powers so destructive that they are very unlikely to happen!

The rocket has a long history behind it. The Chinese are regarded as the earliest users of rockets in war in the thirteenth century. A little later rockets appeared on the battle fields of Europe too. The propulsive agent in these rockets was a mixture of charcoal and salt petre (potassium nitrate). India too was not far behind in this technology. Hyder Ali and Tipu Sultan of Mysore used rockets with great effect against the British in the eighteenth century. But the development of large artillery guns with much greater accuracy retarded the growth of rockets. Till the closing stages of the Second World War rockets were secondary weapons with no guidance mechanisms. The final year of this war saw the employment of the first long range rocket, the V2, by the Germans to bombard London.

But several visionaries envisaged a much grander role for the rocket, that of freeing man from the gravitational chains of the earth and transporting him

to the planets and possibly beyond too. One of them was Konstantin Tsiolkovsky, a Russian school teacher. In 1898, he proposed liquid propellants for rockets, which would ensure much better control of the rocket's flight. He foresaw the use of rockets for long space journeys to the moon and planets. Another pioneer was the American, Robert Goddard, who ploughed a lonely furrow in rocket development, against much scepticism and discouragement. He built and launched the first liquid propelled rocket (using liquid oxygen and gasoline) in 1926. His paper "A method of reaching extreme altitudes" is considered a classic milestone in rocket development.

The main impetus to rocket development in recent decades has been provided by its role as a long range weapon. Advances in electronics made it possible to guide rockets accurately to the enemy targets thousands of kilometres away. The two Super Powers, the USA and the erstwhile USSR, competed with each other in developing these weapons and also engaged in prestige competition with regard to the conquest of space.

To place a satellite in orbit, the rocket carrying it has to reach the "orbital velocity" (about 29,000 km/hr) and to leave the earth altogether and to travel to the planets it has to reach "Escape Velocity" (about 40,000 km/hr). In this race, the Soviet Union was the first to get off the block, by launching into orbit the satellite "Sputnik" in October 1957. The Americans responded by stepping up their efforts. The vast resources that these two giants devoted to this field led to the rapid development of rocketry and space exploration. The most exciting moment of this period occurred on 20 July 1969, when the American astronauts Neil Amstrong and Edwin Aldrin landed on the moon. The world was glued to television sets watching them walk on the moon (clumsily, in their heavy space suits!).

Deeper rocket probes such as the Viking, Pioneer and Voyager have explored the surface of Mars, Venus and Jupiter. Astronomers have learned more about these planets from these probes than from earlier centuries of gazing at them with telescopes But the greatest benefits to humanity from rockets has come from less spectacular operations. Large communication satellites, placed in orbit by rockets, helped to transmit telephone and television signals to cover the whole world. For this purpose, "Geostationary" satellites, that is satellites which match the earth's rotational speed and hence appear to be stationary over a spot on earth (at a height of about 36,000 km!), are used. Three such satellites, properly placed, can cover practically the whole earth. Weather satellites hover over the earth's atmosphere and transmit data on cloud formations, storms etc. Remote sensing satellites give data about forest cover, mineral resources, crop yields etc. A veritable bonanza of benefits have thus flowed from rocketry and space exploration, whose utility was frequently and sharply questioned by many in the earlier stages.

Large rockets are generally of the multi-stage type. Each stage carries its own fuel and oxidiser. Only the final stage carries the "pay load", a satellite or a nuclear bomb. The other stages drop off when the fuel is exhausted.

This way, the range of a rocket is greatly increased since no dead weight is carried at any stage of the flight. Fig. 1 shows schematically a three-stage rocket.

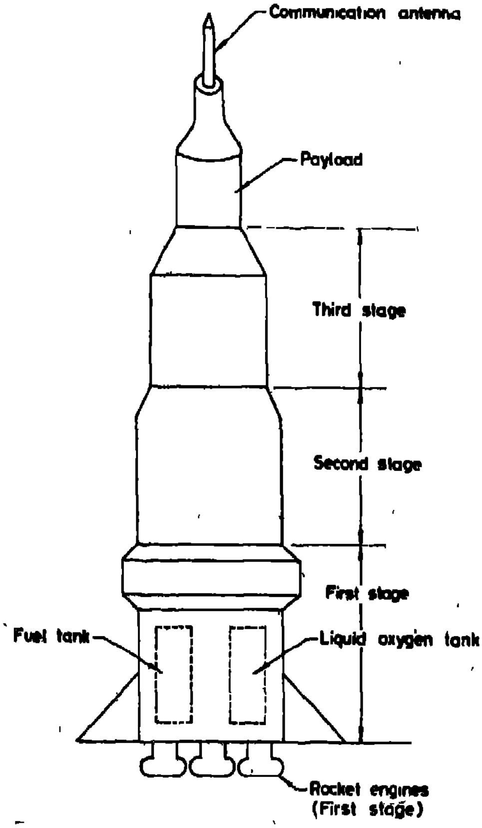

Fig. 1 *Main features of a three-stage rocket*

Rockets are mainly of two types, liquid fuelled and solid fuelled. Fig.2. shows the basic construction of these two types The liquid fuelled rocket Fig.2 (a) carries the fuel in the form of liquid (examples: hydrogen, hydrazine or special grades of kerosene). Liquid oxygen is stored in separate containers High capacity pumps pump the two liquids into the combustion chamber, where they undergo combustion. The hot products of combustion flow through the nozzle at the rear and the reaction propels the rocket forward

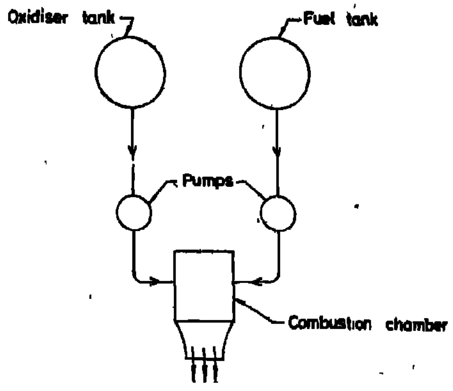

Fig. 2a *Liquid propellant rocket*

In the solid fuel type, the fuel and the oxidiser are in the solid (granule) form and are mixed together in the proper pro-

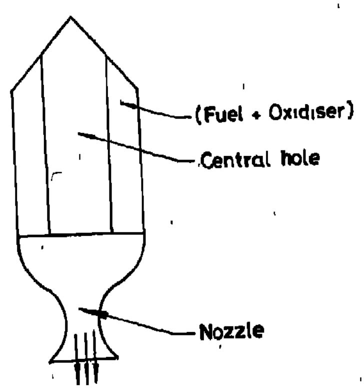

Fig. 2b *Solid propellant rocket*

portion and cast into a block. This block is loaded in the rocket casing (refer Fig.2b). A central hole runs through the block. Examples of solid fuels are nitroneum percholate and ammonium percholate and examples of oxidisers are polymethane and polysulfide. The block is ignited at the end and the burning proceeds towards the other end. The size and shape of the central hole can be used to control the burning rate.

Solid fuelled rockets are preferred for military applications since they can be fired quickly. Liquid fuelled rockets, on the other hand, have been preferred for space probes where control and extended operations are vital.

Both military, (ICBM, IRBM, anti-aircraft, anti-ship etc.) and space probe rockets have extremely sophisticated guidance systems. Unguided rockets are used for signaling rescue work, area bombardment in military operations etc.

Nuclear powered rockets, in which the heat generated by a nuclear reactor is used to heat and expel a gas, are also being investigated.

In sum, rockets have helped us to achieve marvels in communication, weather forecasting etc. But the application that stirs the human imagination most is its function as a chariot to the other worlds. If at some future date we come face to face with other intelligent beings in other worlds, we would have to thank (or curse!) rockets for it.

Reading in Science

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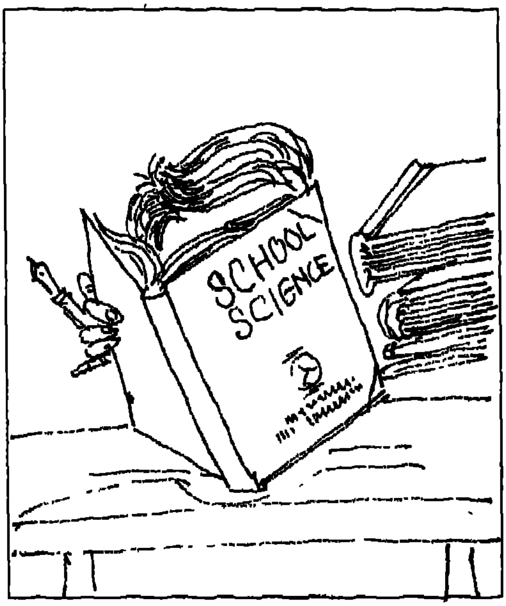

Reading in science is one avenue of learning in this vital curriculum area. There are numerous kinds of subject matter for learners to read. Factual as well as fictional content can be read by pupils in ongoing science units of study. Both should provide for enjoyment and encouragement to attain objectives in the science curriculum. Objectives emphasizing knowledge, skills, and altitudes need to be in the offing. Individual differences must be provided for so that fast, average, and slow learners might well achieve more optimally.

Individualized Reading

I recommend strongly that each pupil has adequate time to select and read trade books on an individual basis. Library books related directly to the science unit being taught need to be located at a learning centre. The books should be on a variety of achievement levels so that each pupil can choose a book that is his/her reading level. It is frustrating for the learner if a library book is too complex to read. Should the chosen book be too easy to read in terms of content, boredom may set in and be an end result. Each pupil must experience challenge and interest in reading a self selected library book.

To further provide for individual differences, library books should be on diverse topics, but definitely related to the unit in science being taught presently. Thus, if pupils are studying a unit on "The Changing Surface of the Earth", they need to be able to select books on a variety of titles such as those pertaining to volcanic eruptions, mountain formation, erosion, climate, and earth quakes. With different topics being covered in library books, each pupil may choose what is of most personal interest. Interest is a powerful factor in motivating pupil achievement. Pupils, when selecting their own library books, read to follow their very own purposes. Possessing perceived purpose also is a motivational force in guiding optimal progress in science achievement. I believe pupils tend to perceive increased purpose or reasons

for reading when self selection of materials is involved rather than the teacher choosing what learners are to read. The content acquired by pupils from reading should be discussed within the unit title emphasized in a contextual setting, not in isolation from other experiences in the current unit being studied in science. For example, if pupils are discussing the causes of earthquakes, what has been read from library books on that topic may be applied in problem solving situations. Or, if learners are studying the causes of volcanic eruptions, reading of subject matter from library books may confirm or modify what occurred in a related science experiment. Interest, purpose, and relating of content acquired are powerful ways of having pupils achieve, learn, and grow in the science curriculum. This is also true when pupils read or experience other kinds of learning opportunities in science. Each pupil reveals different characteristics from others in the classroom and needs personal attention to these individual factors and traits.

With self-selection of reading materials directly related to the present science unit being taught, individual differences in interests and reading levels can be provided for.

Higher Levels of Cognition

The science teacher needs to guide pupils to attain well in higher levels of cognitive domain objectives. Thus, in reading science content, learners must learn to read for different reasons or purposes. Too frequently, pupils have read subject matter to acquire facts. Relevant facts can be salient and important for learner acquisition. Pupils should have ample opportunities to reflect upon factual content read. Thus if pupils have read how sedimentary rocks are formed, they should think about the involved facts. Merely memorizing what has been read makes for a lack of meaning. Questions raised by the teacher and involved pupils about facts read can stimulate thought. Perhaps, the acquired facts can reveal comprehension by using these ideas in new situations. Facts gained then about the formation of sedimentary rocks can be applied to the uses made of this kind of rock in society, such as in building barbecue pits or natural rock, walkways and fences. When pupils read, they should be able to apply or use what has been learned.

When pupils read critically, as an even higher level of cognition, they separate one category of information from another, facts from opinions, fantasy from reality, and accurate from inaccurate content. Thus when learners read about rock formation, they should be able to distinguish the forming of sedimentary from igneous rock, or sedimentary from metamorphic rock. Clarity of ideas is vital when learners categorize knowledge. There are numerous opinions that individuals have about science phenomenon. However, science and its content prizes accuracy of subject matter content acquired. Objectivity is a key concept in studying scientific information. An independent environment outside of the observer's perception is in evidence. Thus content in science is objective regardless of who does the observing. To be might well be to be perceived by someone, but there is an independent reality which does not require an observer. Subjectivity in subject mat-

ter knowledge is then not a part of the knowledge and skills in science. It is true that our knowledge of science changes, such as the ringlets now accepted as being true in the planet Saturn, not the solid core of rings around this planet as was formerly thought to be the case. However, with modern techniques of acquiring information in the world of science, new facts change ideas about scientific knowledge. This is due to improved scientific methods of securing information, not due to changes in the rings around the planet Saturn, unless the changes are due to scientific (objective) data. For example, the surface of the planet earth changes due to volcanic eruptions, earthquakes, and erosion among other factors. So too, many other planets change in time, such as of Saturn.

Creative reading is another salient kind of comprehension in science. Creativity here stresses a desire by the learner to fill gaps in information in the ongoing science unit of study being emphasized. A gap represents what the pupil does not know and would like to fill in the necessary content. Reading is one approach of doing this. Curious learners who lack information at a given point may do more reading to fulfill that gap. The science teacher should assist learners to identify what they do not understand. Learning opportunities guide pupils to fill the gap or the unknown. A creative mind can lead to the next kind of reading comprehension and that being to emphasize problem solving. Pupils should be assisted by the teacher to identify problem areas. These problem areas become broad questions, framed so they allow pupils to secure needed content for answers. A variety of learning opportunities may be used to obtain answers. Reading, experimentation, demonstrations, audiovisual materials, excursions, and discussions are and can be used as learning opportunities to secure information in answer to identified problem areas. Pupils with teacher guidance may select problem areas well as resources to use to obtain answers. Next in problem solving, pupils should develop a hypothesis or answer to the problem. I recommend a brain storming approach here. No value judgements should be made as each pupil provides a hypothesis. The hypotheses may be printed on the chalk board as presented to avoid duplication of answers given by learners The purpose of brain storming is to generate answers. Hypotheses can be tested though experimentation, further reading, use of audiovisual aids, and presentations by qualified resource persons, among other worthwhile procedures. Hypotheses may then need to be revised, if evidence warrants.

There are additional purposes for pupils in reading science content. Thus reading to follow directions can be salient. Individuals in ongoing units of study and in society read directions. These directions must be understood so that they can be followed correctly. Scanning of content is another important purpose in reading content in science. With scanning, the pupil quickly secures an overview of a page or chapter to notice if it contains the necessary information being looked for to solve problems. It so, the pupils may wish to read the rest of the printed ideas. It does save time when a pupil can scan materials to

notice if the rest of the ideas need to be read so that relevant content is secured.

When pupils read to secure a main idea or a generalization, facts will support or refute the accuracy of these broad statements. Thus reading to secure a main idea or a generalization is vital. Facts are relatively easy to forget whereas the broader statements (main ideas or generalizations) are much easier to recall since they are fewer in number as compared to detailed factual content.

Use of Basal Textbook in Science

Basal textbooks, carefully selected, related directly to ongoing units of study can assist pupils to obtain necessary information. The textbook used should be on the reading level of the involved learner so that s/he attaches meaning to what is being read. If the text is too difficult to read orally or silently, the pupil will not understand the contents read. If the text is too easy, boredom may set in for learning on the part of the pupil. The science teacher must observe each pupil to determine if the latter is learning and achieving from the reading experience. Most pupils reveal comprehension from reading if they can answer questions during a discussion covering content of what has been read. However, a few pupils may be shy and not participate in the discussion even though they can read its contents with understanding. Here the teacher needs to encourage all in the classroom to participate. Each pupil needs to attain optimally from reading.

Readiness for reading is important. There is much the science teacher can do to guide pupils to achieve well when reading, even though the content may be slightly difficult for the reader. The teacher then should print in neat manuscript letters words that might cause problems in identification for pupils when reading. These words can be printed in isolation or within a contextual situation in sentences. In the latter case, each possible new word needs to be underlined or highlighted. The teacher should then guide pupils to pronounce each new word correctly as listed on the chalkboard. Learners should also understand the meaning of each word either through a brief definition or through use in a sentence. The Glossary located in back of the basal can assist pupils in securing definitions for new words. Pupils need to possess adequate background information in order to attach meaning to what will be read in the reading assignment. If pupils are to read about volcanic eruptions, they should have the needed prerequisite content to understand what is being read. A purpose or reason for reading needs to be stressed. The purpose can be in question form from the teacher and better yet from learners themselves. Pupils should then be ready to read so that information in answer to these questions can be gathered.

The follow up to the actual reading activity is a must. Interest in reading and the follow up is extremely important. The following are suggested as follow up experiences for learners:

1. Discussing what has been read such as answering the questions in the purpose.
2. Outlining selected ideas from the reading selection.
3. Summarizing major subject matter read by listing main ideas.
4. Drawing a series of illustrations to

reveal understandings gained.

5. Dramatizing ideas acquired.
6. Using attained ideas to solve problems or check hypotheses from ongoing science experiments.
7. Doing experiments based on content read.
8. Reading from other reference sources to confirm or modify subject matter contained in the basal.
9. Researching related data by using reputable sources of information.
10. Engaging in a homework activity by identifying and solving a relevant problem.

Using a basal science textbook can truly become a good learning activity if pupils understand and can apply information obtained. Subject matter should make sense to the pupil and not be trivialized. The pupil needs to reflect upon its meaning, think critically and creatively about its contents, and make use of ideas to solve problems. Providing readiness for pupils prior to reading is time well spent for the science teacher. A relevant science curriculum will have as one of its learning opportunities the skill of reading; other kinds of materials to use in teaching-learning situations will include the semiconcrete and concrete means of learning. Reading stresses the use of abstract materials in the science curriculum. Additional abstract experiences include listening, speaking, and writing. The latter three kinds of abstract learning activities need elaboration so that related reading skills might be increased for each learner.

Listening in the Science Curriculum

Listening well assists pupils to achieve more optimally since we learn much from listening to others. In small and large group discussions within a science unit, pupils should develop skill to grasp ideas readily. It might be that any spoken ideas is said one time only. If a pupil did not secure the idea, s/he has not learned as much as possible. Then too, what one fails to secure as a result of listening may also hinder from obtaining other information due to its contextual setting. There are numerous purposes or reasons for quality listening in the science curriculum. Among others, these include listening to:

1. A discussion of an ongoing science experiment such as problem selection, possible solutions to the problem, data gathering, and appraisal of the solutions offered previously.
2. An evaluation of ideas presented in a science demonstration. Content therein should be appraised and evaluated.
3. A book report on a relevant issue in science.
4. Acquiring information from a committee project when elaborated upon by its members.
5. A creative or formal dramatization pertaining to the life and times of a scientist.
6. Poetry written pertaining to an ongoing science unit.
7. Showing and explaining a mural developed by volunteers in an ongoing science unit of study.
8. A cassette recording related to a lesson presentation.
9. A video-tape on a selected topic in science.
10. Creative prose written by learners such as tell tales, myths, legends, and others, relating to the interest of pu-

pils in science.

To provide for individual difference, pupils need to experience a variety of activities in science. Each pupil needs to learn as much as possible. Learners differ form each other in learning styles possessed. This means that different activities should be available for learner interaction.

Speaking Activities in Science

A variety of rich speaking experience should be available to pupils so that quality communication in science is achieved by each. The teacher needs to guide the concept of *excellence* in oral communication. Scientists tend to be strong in oral communication skills. Pupils too should be assisted to truly communicate well with others. What might pupils learn to communicate in science well so that effective interpersonal interaction is in evidence?

1. The development and results of a science experiment
2. The complete reading of ideas contained in a textbook, library book, journal, or other printed materials related directly to an ongoing science unit.
3. Oral reports given pertaining to content read inherent in a lesson.
4. Main ideas circulating within a committee setting.
5. Brain storming to solve a problem within the class as a whole.
6. Dramatic endeavours to communicate selected content to peers.
7. Reader's theatre to present specific subject matter to listeners.
8. Purposes involved in planning, developing, and evaluating a project in science.
9. Pupil demonstration and explanation of a phenomena being studied in science.
10. Committee exploration of methods of solving an identified problem area in science.

The science teacher must have as a major goal in the science curriculum to assist pupils to be able to communicate well so that more optimal attainment for each learner is an end result.

Writing in Science

Writing can be a difficult skill to achieve when proficiency is involved. Abstractions are stressed here such as symbols representing content in science. The symbols pertain to a code that must be broken to read and understand subject matter. When writing, the situation is reversed, the writer encodes so that a reader can ascertain the inherent ideas. The encoding with letters to represent words and larger units such as sentences, paragraphs, and entire selections must be accurate and complete. Vagueness and lack of coherence must be eliminated in writing. What pupils learn in language arts can then be transferred to the area of writing in science. The following salient writing purposes need to be stressed in science :

1. The plan and results of a science experiment.
2. Notes taken over content read from the basal text.
3. Outlines written covering a relevant selection.
4. Business letters written to order vital materials pertaining to a unit of study.
5. Friendly letters written to pen pals to share ideas about what is presently being studied.
6. Diary entries written pertaining to subject matter acquired on successive days of learning.

7. Log entries recording coverage of content covering a week or for the entire unit of study.
8. Journal writing reflecting upon the learner's achievements for and in learning.
9. Written book reports telling a few major ideas acquired from reading.
10. A formal dramatization in which play parts are written for the life and times of a famous scientist.

A variety of writing activities should be in the offing so that pupil proficiency is developed when communicating ideas. Individual differences in writing achievement need to be considered by the science teacher. The pupil and teacher need to appraise what the former has attained previously in order to ascertain if improvement in writing has occurred in the present completed sample of written work. A folder for each pupil's written work needs to be kept so that earlier written work can be compared with later products to notice progress of the learner in writing for a variety of purposes.

In Conclusion

Reading of subject matter in science is a salient activity along with other kinds of experiences involving the concrete and the semiconcrete. The science teacher needs to be certain that pupils are ready for reading content prior to the actual reading activity. This is especially true of reading from the basal text. Thus the teacher should have pupils see and attach meaning to the new words in the text prior to reading. Learners also need adequate background information of what will be read, prior to reading. A reason or purpose for reading will increase reading comprehension. Thus pupils have framework or questions to answer in reading for ideas, facts, concepts, and generalizations.

There should be a follow up of experiences after pupils have completed reading a given selection so that comprehension and retention of content is in evidence.

Complimenting the reading activity are listening, speaking, and writing activities. Diverse kinds of activities are in evidence here to encourage pupils to communicate ideas clearly through speaking and writing, as well as acquire subject matter through reading and listening. Pupils individually need to achieve as much as possible in ongoing lessons and units of study in science.

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Brain-storming Problems in Mathematics for School Teachers

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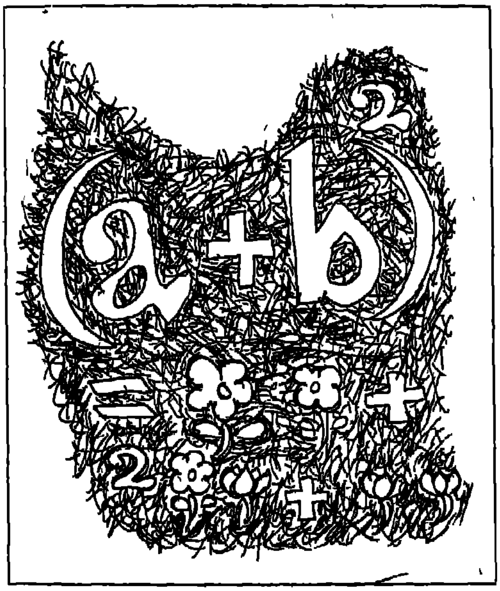


Learning of mathematics can hardly be limited to only to the classroom and to what is contained in the textbooks. A good teacher has the responsibility to tap numerous resources before handling a classroom lesson. Creation of interest in mathematics should be one of the objectives of a teacher A teacher of today has to devote more time and energy to productive and creative activities, interaction, discussions and to update his knowledge. In addition to curricular coverage, he has to see the interest of talented students. He should motivate the children to solve some of the challenging problems in mathematics to give good insight in mathematics and development. He should encourage them to take various Olympiads examinations which are regular feature of the country now-a-days.

The following are eight problems with solutions, in mathematics, in continuation to the paper submitted in *School Science*, March 1996 issue. These may be useful for school teachers as well as for talented children.

Problem 1: Find all integer values of "a" such that the quadratic expression (x+a) (x+w) + 1 where w is an integer can be factored as a product of (x+b) (x+c) where b, c are integers.

Solution

$(x+a)(n+w)+1 = x^2 + (a+w)x + aw + 1$

This expression can be factored as (x+b) (x+c) with b, c as integers if and only if the discriminant is a perfect square i.e.

$(a+w)^2 - 4(aw+1) = (a-w)^2 - 4$ ....(1)

Say it is m^2 for some non-negative integer m.

Let a–w=n where n is a positive integer.

Then $(a-w)^2-4 = n^2-4 = m^2$

$\Rightarrow n^2-m^2 = 4 \Rightarrow (n-m)(n+m) = 4$

Since n+m is a positive integer that divides 4, we must have n+m=1, 2 or 4.

If $n+m = 1$ then $n-m = 4$

If $n+m = 4$ then $n-m = 1$

In either case m, n are both non-integers and therefore these possibilities must be rejected.

If $m+n = 2$ then $n-m = 2$

$\Rightarrow n=2, m = 0$ which gives from (1)

$(a-w)^2-4 = 0 \Rightarrow a = w\pm2$

Hence $a = w+2$ or $w-2$

Problem 2 : Prove that $(2222)^{5555} + (5555)^{2222}$ is divisible by 7.

Solution : $(2222)^{5555} + (5555)^{2222}$

$= (7777-5555)^{5555} + (7777-2222)^{2222}$

$= (7777)^{5555}[1-\frac{5555}{7777}]^{5555}+(7777)^{2222}[1-\frac{2222}{7777}]^{2222}$

$= (7777)^{2222}[(7777)^{3333}(1-\frac{5555}{7777})^{5555}$

$+ (1-\frac{2222}{7777})\ ]^{2222}$

$= 7^{2222} \times (1111)^{2222}$[same expression as above]

The above is divisible by 7.

Problem 3 : The lengths of the sides of a right angled triangle are x metres, y metres, and z metres, where x,y,z, are natural numbers having no common factor. Show that x,y,z, must be of the form m^2-n^2, $2mn$, m^2+n^2 (in some order). m & n being suitable natural numbers.

Solution : As x, y, z, are the sides of a right angled triangle $\therefore x^2+y^2 = z^2$

Since x,y & z are natural numbers and they do not have any common factor.

So both x and y cannot be even. Because if these two have a common factor then it becomes a factor of z^2 also.

So both x and y cannot be odd also. Let $x = 2u+1$ and $y = 2v + 1$

$\therefore z^2 = x^2 + y^2 = (2u + 1)^2 + (2v + 1)^2$

$= 2[2u^2 + 2u + 2v^2 + 2v + 1]$

The RHS must be a perfect square. Moreover all perfect squares divisible by two are divisible by four also. It shows that z^2 is divisible by 2 but not by 4, which is impossible.

The only possibility left is that one is odd and other is even.

Now $x^2 = z^2-y^2 = (z+y)(z-y)$

let $x = 2t \Rightarrow x^2 = 4+2$

Now z and y are both odd

$\therefore (z + y)$ and $(z - y)$ both are even.

let $z + y = 2m^2$ and $z - y = 2n^2$

By adding $z = m^2+n^2$ and $y = m^2-n^2$ and $n^2=z^2-y^2 =(m^2 +n^2)^2-(m^2-n^2)^2= 4m^2n^2$

$\therefore x = 2mn$

Hence the three sides of the right angled triangle must be of the form $m^2 + n^2$, $2mn$, $m^2 - n^2$

Problem 4 : The number 3 can be expressed as a sum of one or more positive integers in four ways, namely 3, 1+2, 2+1 and 1+1+1. Show that any positive integer n can be so expressed in 2^{n-1} ways.

Solution : 1 can be expressed as a sum of one or more positive integers in One way

2 can be expressed as 2, 1+1 Two ways

3 can be expressed as 3, 1+2, 2+1, and 1+1+1 Four ways

4 can be expressed as 4, (3+1, 1+3), (2+2) (1+1+2, 1+2+1, 2+1+1) (1+1+1+1) (sum of two integers) Eight ways

Similarly n can be expressed as n, sum of two integers, sum of three integers .... sum of $\underbrace{1+1+1+.......+1}_{\text{(n times)}}$

Thus sum of all numbers is

${}^{n-1}C_0 + {}^{n-1}C_1 + \dots\dots\dots + {}^{n-1}C_{n-1} = 2^{n-1}$

Problem 5 : Which of the following expression is greater?

$$\frac{2.00000000003}{(1.00000000002)^2 + (2.00000000003)}$$

or

$$\frac{2.00000000002}{(1.00000000002)^2 + (2.00000000002)}$$

Solution : Let $10^{-11} = p$

Then the two fractions become

$$\frac{2+3p}{(1+3p)^2+(2+3p)} \quad \text{and} \quad \frac{2+2p}{(1+2p)^2+(2+2p)}$$

$$\text{or} \quad \frac{1}{1+\frac{(1+3p)^2}{(2+3p)}} \quad \text{and} \quad \frac{1}{1+\frac{(1+2p)^2}{(1+2p)}}$$

First fraction $\gtrless$ second fraction according as

$$\frac{(1+3p)^2}{(2+3p)} \lesseqgtr \frac{(1+2p)^2}{(2+2p)}$$

or $(2+2p)\ (1+3p)^2 \lesseqgtr (1+2p)^2\ (2+3p)$

or $2+14p+30p^2+18p^3 \lesseqgtr 2+11p20p^2+12p^3$

LHS > RHS

Hence First fraction > Second fraction.

Problem 6 : A four-digit number has the following properties

(a) It is a perfect square

(b) Its first two digits are equal to each other

(c) Its last two digits are equal to each other

Find all such four-digit numbers.

Solution : We want to find positive integers x and y at $1 \le x \le 9$

$x\ x \le y \le 9$ and xxyy is a perfect square

Since $10^2 = 100$(3 digits) and

$100^2 = 10000$ (five digits)

It follows that xxyy must be a square of a two-digit number. Suppose that $(ab)^2 = xxyy$.

The number is clearly a multiple of 11.

Since it is a perfect square it must be a multiple of 11^2 (=121)

Therefore it must be of the form 121x1, 121x4, 121 x 16

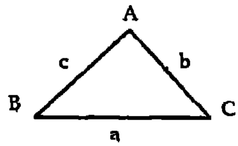
121x36, 121x49, 121x64, 121x81

Out of these only 121x64 (=7744) is the form xxyy

Thus the number is 7744.

Problem 7: Prove that the sum of the sides of the angles of a triangle never exceeds $3\frac{\sqrt{3}}{2}$ and the equality holds only when the triangle is equilateral.

Solution : In a triangle ABC, $S = \frac{a+b+c}{2}$



$$\text{Sin } A = \frac{2}{bc}\sqrt{s(s-a)\ (s-b)\ (s-c)}$$

$$\text{Sin } B = \frac{2}{ac}\sqrt{s(s-a)\ (s-b)\ (s-c)}$$

$$\text{Sin } C = \frac{2}{ab}\sqrt{s(s-a)\ (s-b)\ (s-c)}$$

$\therefore$ Sin A + Sin B + Sin C

$$= \sqrt[2]{s(s-a)\ (s-b)\ (s-c)}\left[\frac{1}{bc}+\frac{1}{ca}+\frac{1}{ab}\right]$$

$$= 4s\sqrt{\ } s[\ \sqrt{(s-a)\ (s-b)\ (s-c)}]\ [\ \frac{1}{abc}\ ]$$

Since S is a constant, the above product (i.e. Sin A + Sin B + Sin C) is maximum when s-a = s-b = s-c and $\frac{1}{a} = \frac{1}{b} = \frac{1}{c}$

i.e. a = b = c (Δ is equilateral)
Maximum value

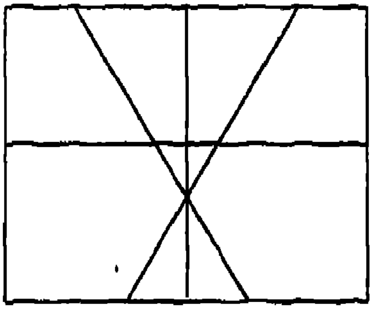
$$= 4.\ \frac{3a}{2}\sqrt{\frac{3a}{2}}\left[\sqrt{\frac{a}{2}}\sqrt{\frac{a}{2}}\sqrt{\frac{a}{2}}.\frac{1}{a}.\frac{1}{a}.\frac{1}{a}\right]$$

$$= 3\frac{\sqrt{3}}{2}$$

Hence $\operatorname{Sin} A + \operatorname{Sin} B + \operatorname{Sin} C \leq 3\ \frac{\sqrt{3}}{2}$

Problem 8 : What is the greatest number of parts into which a plane can be divided by (a) n straight lines (b) n circles

Solution : (a) By one straight line we can divide a plane into two parts and by two we can divide the plane into four parts and with three lines we can divide the plane into 7 parts.



with four lines

$\therefore$ Sum of all these is given as follows

$S = 2+4+7+11+.....+T_n$

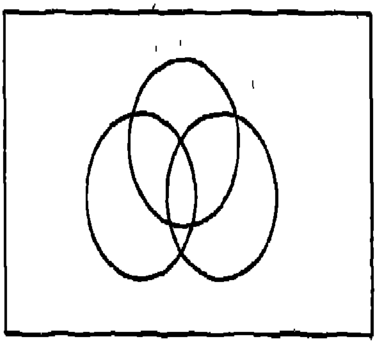
$S = 2+4+7+......T_{n-1}+T_n$

$\therefore T_n = 2 + (2 + 3 + 4 + ...\overline{n\text{-}1}\text{ terms})$

$= 1 + (1+2+3+4+ ...\overline{n}\text{ terms})$

$$= 1 + \frac{n(n+1)}{2}$$

(b) By one circle we divide the plane in to two parts. Two circles can divide the plane at most into 4 parts. Three circles can divide the plane into at most eight parts. Four circles divide the plane into at most 14 parts.



with three circles

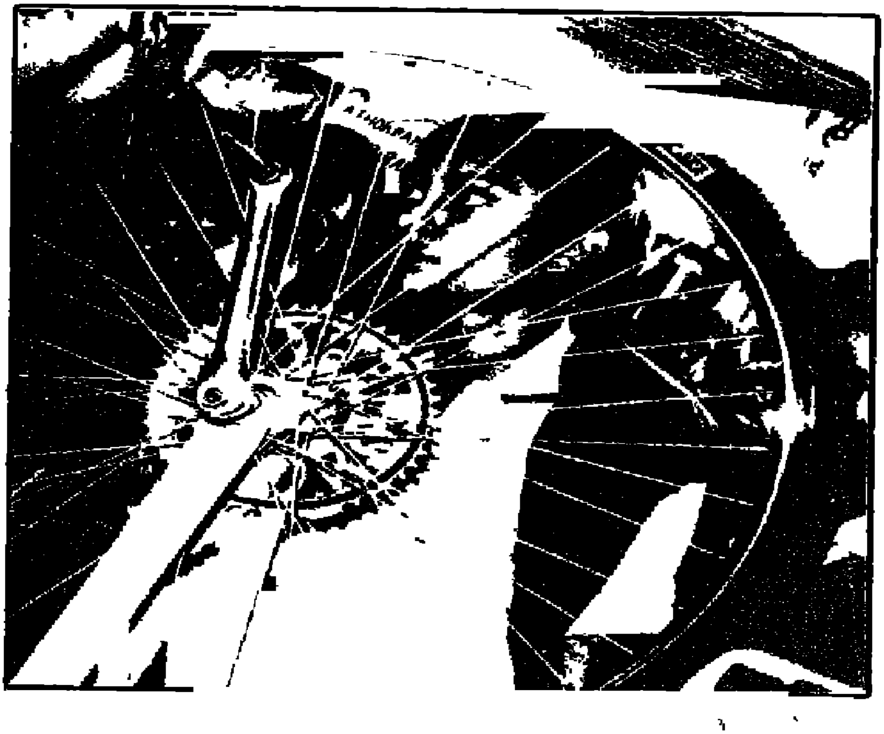
$S = 2+4+8+14 +......+T_n$

$S = 2+4+8+ ...T_{n-1} + T_n$

$T_n = 2+(2+4+6+...\overline{n\text{-}1}\text{ terms}) = 2+n^2-n$

Down the Memory Lane

Photo Feature on Science Exhibition

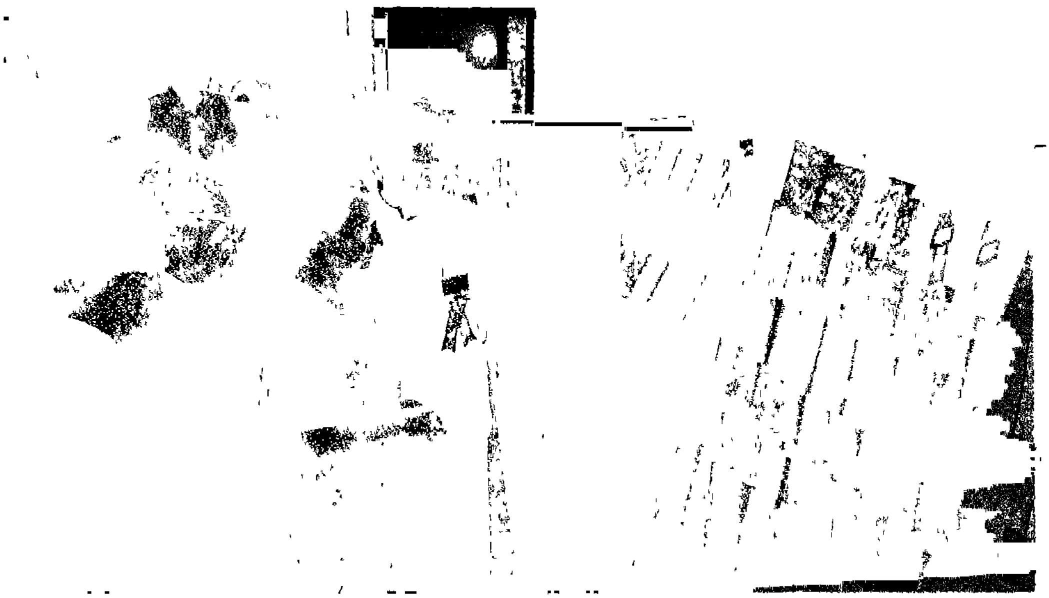


Demystifying the DNA Molecule, New Delhi, 1971.

Learning Mathematics through models, New Delhi, 1971.

Demonstrating the Physics Kit, New Delhi, 1971.

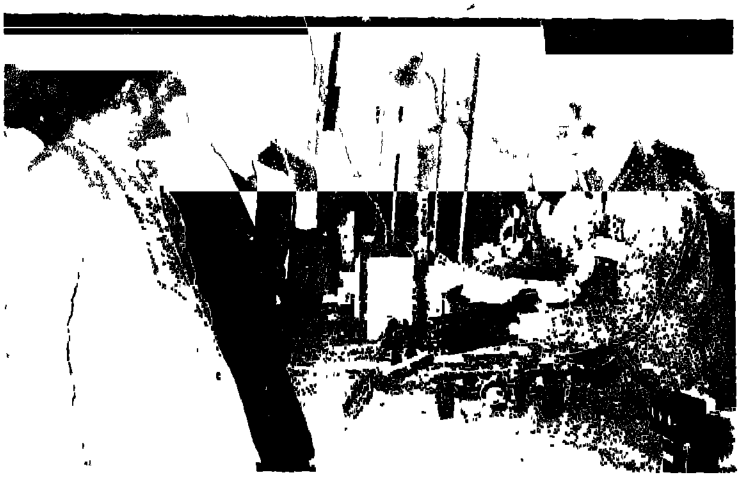
Shri V.V. Giri, President of India, inaugurating the NSEC, New Delhi, 1972. Smt. Indira Gandhi, Dr Karan Singh, Professor Nurul Hasan and Professor D.S. Kothari are also seen in the picture.



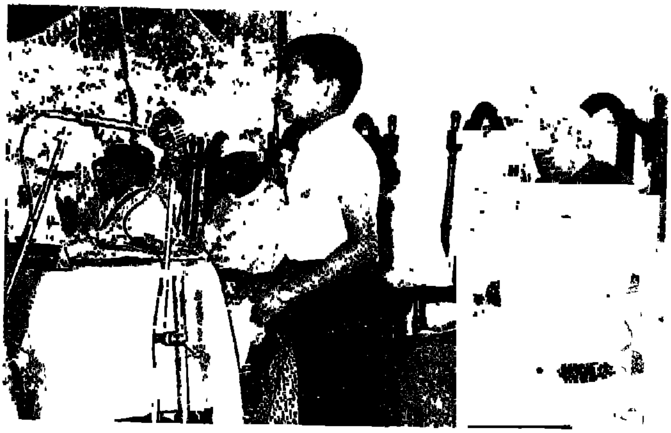
Professor S.V.C. Aiyya, Director, NCERT showing science publications of the Council to Smt. Indira Gandhi.

Guidance on dispaly from Dr. Karan Singh, Bombay, 1979. NSEC, 1980, New Delhi

President, Shri F.A. Ahmed, the Prime Minister Smt. Indira Gandhi and Professor Rais Ahmed, Director, NCERT appreciating an exhibit displayed by a participant from Bhutan, New Delhi, 1975.

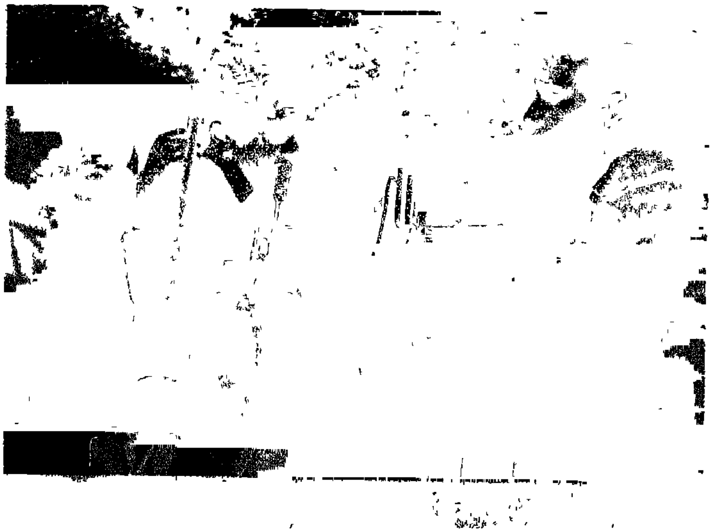


A participant demonstrating his model of an innovative bullock cart to Shri P.C. Chunder, Education Minister, New Delhi, 1977.



A child participant presenting a vote of thanks at the inaugural of the exhibition, New Delhi, 1980.

President, Shri N Sanjiva Reddy, Prime Minister, Smt. Indira Gandhi and the Education Minister, Shri S.B. Chavan visiting the exhibition, New Delhi, 1980.



'Let me explain what it is ...' a participant demonstrating is exhibit, New Delhi, 1980

President Giani Zail Singh interacting with a participant, Udaipur, 1985.

'Not just a sewing machine, it can also wind up thread and generate light', Udaipur, 1985.

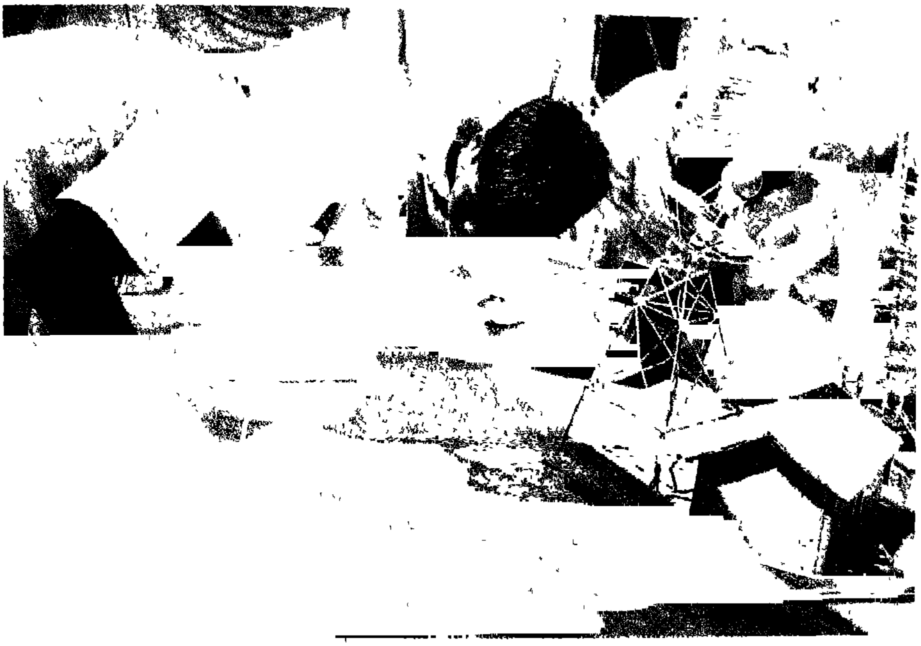
Welcome with a bouquet, Guwahati, 1986

'It is not as simple as it appears to be', a young visitor trying to grasp the working of an exhibit, Guwahati, 1986.

From child to child, Guwahati, 1986.

Seeing is believing: Solar energy in action, Hyderabad, 1989.

Robust Worker of the future: Working model of a robot, Hyderabad, 1989.



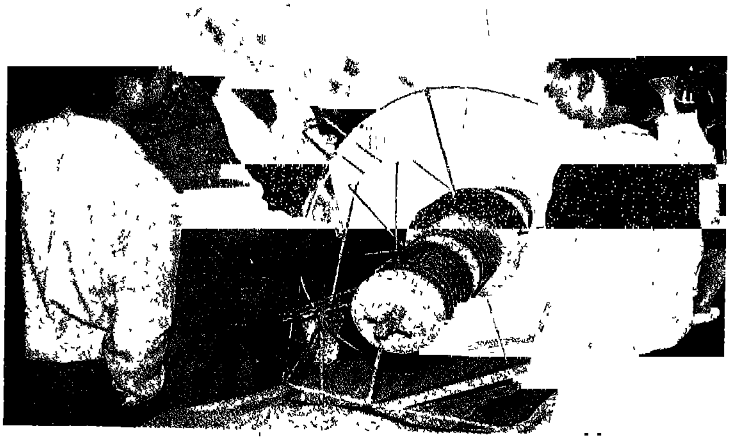
Toiling for the big event : Children busy in reassembling their exhibits, Hyderabad, 1989.

'You too can save energy by using the device developed by me, Patna, 1990.

'Energy can neither be created nor destroyed but can be transformed into other forms', explains the young scientist through demonstration, Patna, 1990.

Simulating satellite communication, a participant explaining the principle of satellite communication to curious visitors, Patna, 1990.

Enlarge or reduce the size of a drawing at will. Working model of a pentograph, Jabalpur, 1987.



A teacher helping to demonstrate an exhibit, Jabalpur, 1987

President, Shri R Venkataraman visiting the exhibition held at Jabalpur, 1987.

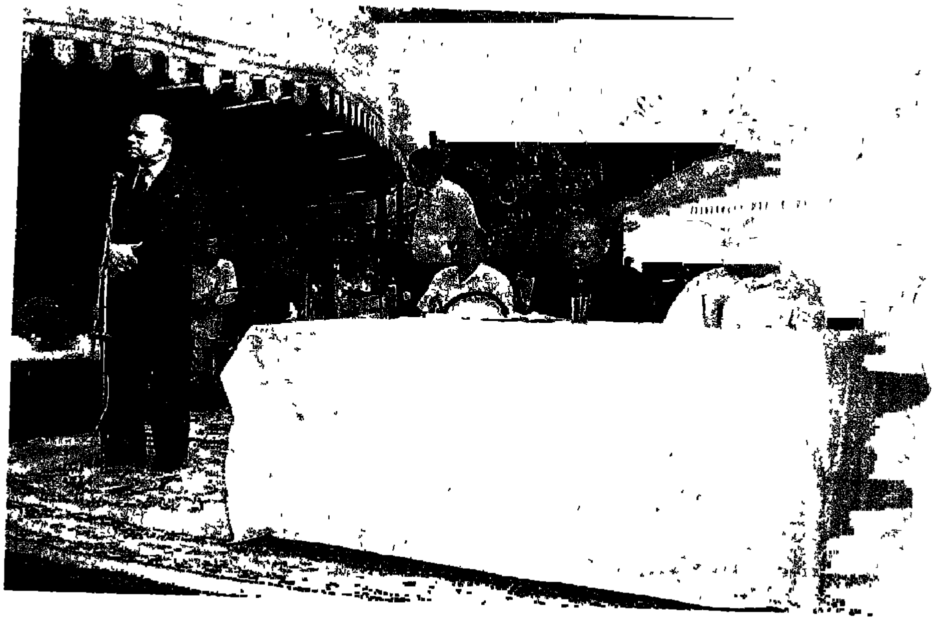
Distinguished visitors. President, R. Venkataraman, Shri Jagmohan, Governor, J & K, Union Education Minister and Education Minister, J & K, Jammu, 1998.

A cultural evening organised by the participants is a regular feature of NSEC : A scene enacted at Jammu, 1988.

Prime Minister, Shri P.V. Narasimha Rao testing a device on display, New Delhi, 1995.

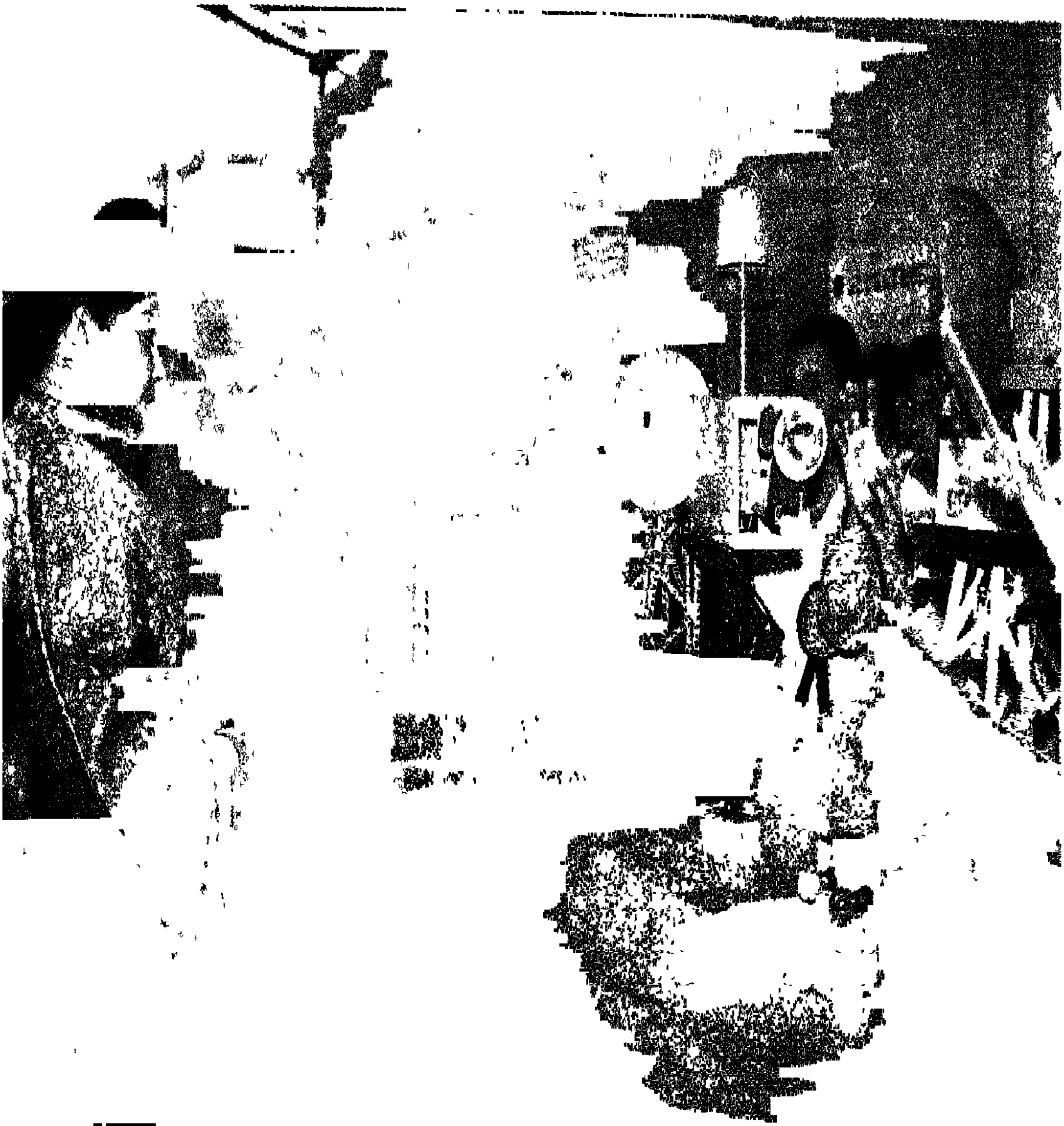
Counting heartbeats with a digital counter, New Delhi, 1995.

A keen observer, New Delhi, 1995.



'We shall meet again in 1996', Dr. K.S. Bhoi, HRD Minister of State, Shri Sahib Singh Verma, Education Minister, Delhi, Professor A.K. Sharma, Director, NCERT at the closing function of JNNSEC, 1995, New Delhi

A participant explaining his exhibit to Shri Arjun Singh, Human Resource Development Minister, Ms. S Jayalalitha, Chief Minister, Tamil Nadu and Professor A.K Sharma, Director, NCERT, Madras, 1994.



President, Shri R. Venkataraman and Shri K. Karunakaran, Chief Minister, Kerala, interacting with a participant, Kochi, 1992.

Waiting for their turn · Long queues of visitors are common feature of all INNSECs, a scene from Madras, 1994

Demonstration of Recoil of Gun

A Low-cost Teaching Aid

M.G. Tarnekar
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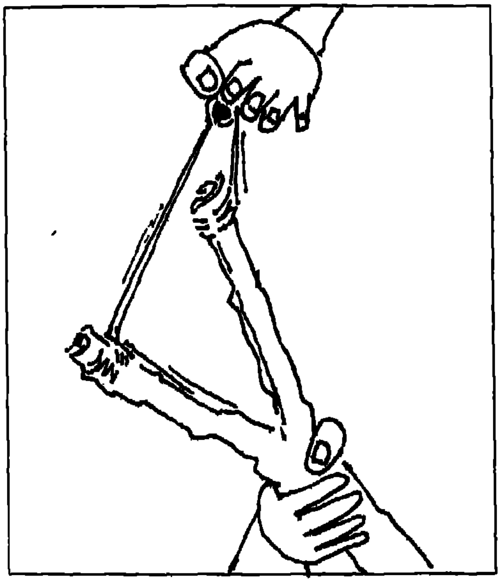
Raipur, M.P



A rectangular piece of wood (thematerial and its shape are optional) having its bottom surface sufficiently plane, is taken. On its top surface, two wire-nails (each of length 2 cm) are fixed at 'A' and 'B' and a third similar nail is fixed at 'C'. A rubber-band is put around 'A' and 'B' and to its mid-point 'm' a piece of thread is tied, the other end of which is pulled towards 'C' and tied to it. The rubber-band gets stretched in this position increasing its potential energy depending on the pull on the thread mC.

One small stone (or a steel/marble/glass ball as is freely available) is kept within the stretched rubber-band.(Fig.1)

On a plane horizontal table-top (even a smooth horizontal plane floor will do) some hollow rollers, in practice empty ball-point pen refills, were laid at a certain distance (say 3 cm) and parallel to each other.

The wooden block, already prepared as described above now onwards called Gun was placed on these rollers. Care should be taken that it rests on, at least, three rollers (accordingly the distance between the successive rollers be adjusted). This loaded gun can move on these rollers in almost friction-free manner.

Demonstration of the Law of Conservation of Momentum

Once the above preparation is over, and the gun is at rest, it can be said that the total momentum of the system (gun and the ball) is zero.

Now with the help of a match-stick we burn the thread. The rubber-band returns to its original shape and position, releasing all of its P.E. and throwing the stone/ball away from the gun with an equal amount of kinetic energy. The stone flies away to a sufficiently long distance, depending on its mass. Instantly, the gun starts travelling in the opposite direction. Distance travelled by it depends on its mass.

This demonstrates the principle of conservation of linear momentum. The momentum of the ball and the momentum of the gun are equal and opposite.

More Types of Observations

Keeping the tension in the rubber-band the same each time (checked by the same length of the thread Cm), and using stones/balls of different masses, we can study the motion of balls and the gun. For simplicity, the distances travelled by them can be taken as the measure for this purpose.

By keeping the same ball and changing the tension, we can repeat the experiment. Here the energy is varied and thus the velocities of the ball and the gun get altered effectively.

Mass of the gun (block) can be altered by taking different blocks (or by fixing another similar block at the bottom of the first) and it can be seen that the heavier block travels a smaller distance as compared to a lighter one, using the same tension and the stone in both the cases.

The experiment can be repeated by changing different parameters and the phenomenon can be observed in details. Thus a deeper insight in the conservation law for linear momentum can be developed.

Conclusion

The author is pleased to state that the instrument that was fabricated from old used chalk-dusters and empty ball-point pen refills worked very well in demonstrating the law. The fabrication can be done by each student, individually, and does not involve any financial burden on the laboratory. All the other items can be easily obtained at a negligible cost.

Four or five different blocks and a few balls of various sizes are sufficient to have more than fifty different observations Because of the friction-free motion the scene is highly spectacular, and one cannot resist appreciating it. Measurement of various parameters involved, can, of course further add to the quantitative nature of this demonstration

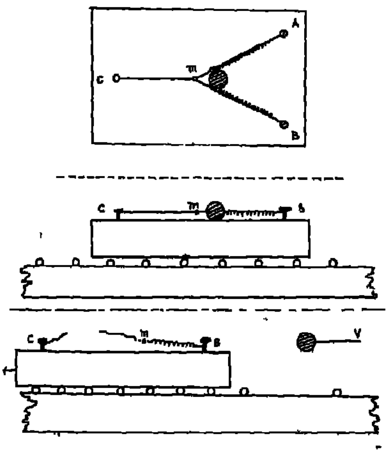
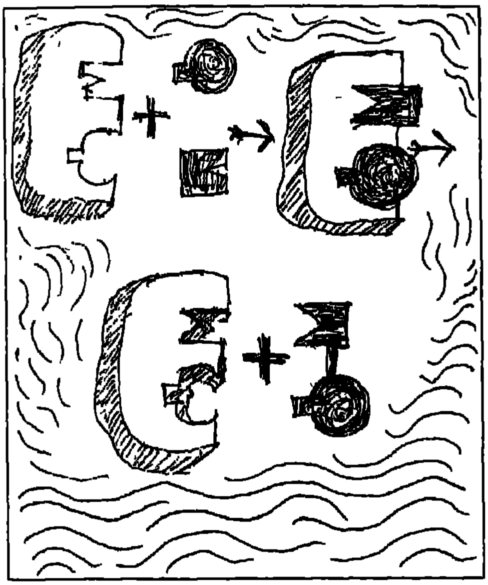


Fig. 1 Conservation of Linear Momentum

A Quiz on Hormones

Vijay Deshpande
Reader
Department of Biochemistry
Osmania University
Hyderabad



Section A

Choose the correct answer :

1. Which of the following does not represent an endocrine gland?
   (a) thymus (b) adrenal (c) pancreas (d) spleen
2. The pineal gland — a small pine cone-shaped structure located between the cerebral hemispheres of the brain secretes melatonin. The hormone is involved in :
   (a) growth (b) location (c) skin colouration (d) lightening of skin.
3. Select a non-steroid hormone
   (a) testosterone (b) adrenaline (c) estrone (d) progresterone
4. An example for a protein hormone is
   (a) oxytocin (b) thyroxine (c) aldosterone (d) follicle stimulating hormone.
5. Deficiency of anti-diuretic hormone causes
   (a) diabetes (b) diabetes mellitus (c) diabetes insipidus (d) none of these
6. Which one of the pituitary hormones influence lactation (milk production)?
   (a) oxytocin (b) prolactin (c) thyroxine (d) human chorionic gonadotropin.
7. The menstrual cycle in females is regulated by one of the endocrine gland :
   (a) pineal (b) pancreas (c) pituitary (d) thymus.
8. Goitre can be treated by
   (a) removal of thyroid gland (b) administration of goitrogen (c) use of iodised salt (d) use of radioiodine
9. A hormone liberated during fear and flight in vertebrates is
   (a) adrenaline (b) oxytocin (c) insulin (d) none of these
10. Diabetes can be produced in experimental animals by administration of
    (a) insulin (b) alloxan (c) chloropropamide (d) oxytocin.

Section B

Fill in the blanks with suitable words or phrases :

1. Hormones are substances produced by ....glands.
2. Thyroid hormones regulate................in amphibians.

3. In humans, the sexual cycle is termed as menstrual cycle whereas in animals it is known as................
4. Hyper functioning of parathyroid leads to ....
5. Hormones are quantitated in biological fluids by immunological techniques such as................and................
6. The only endocrine gland which has the capacity to accumulate iodine is the................
7. Gigantism in medical terms is known as................
8. Deficiency of insulin causes................
9. ...., a steroid hormone influences mineral metabolism.
10. Thyrotropin also known as thyroid stimulating hormone regulates the activity of................the endocrine gland.
11. 1.25 dihydroxy cholecalciferol, a hormone, regulates................metabolism.
12. A pancreatic hormone which has an effect opposite to that of insulin is................
13. An example for an adrenal medullary hormone is................
14. Deficiency of adrenocorticosteroids leads to................disease.
15. The Islets of Langerhands produce two hormones,................and................

Section C

Indicate whether the following statements are true or false.

1. Hormones are also known as chemical messengers.
2. Insulin, the proteinaceous hormones is active when administered orally.
3. Removal of pituitary gland from an experimental animal is termed as hypophysectomy.
4. Hormones are substances produced by ductless gland and are present in blood at very high concentrations.
5. Hormones elicit their action at a site distant from its synthesis.
6. The process of digestion is not controlled by hormones.
7. Parathormone, a hormone produced by parathyroids regulates calcium metabolism.
8. Skin colouration is due to the influence of melanocyte stimulating hormone, a pituitary hormone.
9. Diabetes can be produced in experimental animals by removal of pancreas.
10. The secondary sexual characters in males and females are determined by gonadal hormones.
11. Deficiency of insulin causes decreases in blood sugar level or hypoglycemia.
12. Hormones have to be supplemented in the diet regularly.
13. The androgens and estrogens are the male and female hormones, respectively.
14. Presence of human chorionic gonadotropic, a pituitary hormone in urine of females indicates pregnancy.
15. Diabetes mellitus is diabetes insipidus.
16. Goitre arises due to deficiency of thyroid hormones.
17. The activity of gonads (ovary and testis) are under the control of pituitary.
18. Deficiency of growth hormone causes dwarfism.
19. Exophathalmic condition (protrusion of eye balls) is characteristic of hypothyroidism.
20. Melanin is the skin colouring pigment.

Section D

Expand the following abbreviations used in hormones :

1. TSH ------------------------------
2. LH ------------------------------
3. GH ------------------------------
4. PRL ------------------------------
5. MSH ------------------------------
6. FSH ------------------------------
7. hCG ------------------------------
8. CT ------------------------------
9. PTH ------------------------------
10. ADH ------------------------------
11. ACTH ------------------------------
12. T_4 ------------------------------
13. T_3 ------------------------------
14. TRF ------------------------------
15. GH-RF ------------------------------
16. Gn-RH ------------------------------
17. NGF ------------------------------
18. EGF ------------------------------
19. IGF ------------------------------
20. FGF ------------------------------

Section E

Match the following :

Endocrine gland	*Hormone*
1. Thyroid	Insulin
2. Parathyroid	Testosterone
3. Anterior pituitary	Oxytocin
4. Posterior pituitary	Thyroxine
5. Testis	Growth hormone
6. Ovary	Releasing factor
7. Pineal	Estrone
8. Pancreas	Epinephrine
9. Hypothalamus	Melatonin
10. Adrenal	Parathormone

Answers

Section A

1.d 2.d 3.d 4.d 5.c 6.b 7.c 8.c 9.a 10.b.

Section B

1. endocrine or ductless
2. metamorphosis
3. oestrous cycle
4. hyperparathyroidism
5. radioimmunoassay (RIA) and enzyme-linked immunosorbent assay (ELISA)
6. thyroid
7. acromegaly
8. diabetes mellitus
9. aldosterone
10. thyroid
11. calcium
12. glucagon
13. adrenaline/noradrenaline
14. Addison's
15. insulin and glucagon

Section C

1. True 2. False 3. True 4. False 5. True 6.False 7. True 8.True 9.True 10. True 11. False 12. False 13. True 14. True 15. False 16. True 17. True 18. True 19. False 20. True.

Section D

1. Thyroid stimulating hormone or thyrotropin
2. Lutenising hormone
3. Growth hormone
4. Prolactin
5. Melanocyte stimulating hormone
6. Follicle stimulating hormone
7. Human chorionic gonadotropin
8. Calcitonin
9. Parathormone
10. Anti-diuretic hormone

11. Adrenocorticotrophic hormone
12. Tetriodothronine or thyroxine
13. Triiodothyronine
14. Thyrotropin releasing factor
15. Growth hormone releasing factor
16. Gonadotropin releasing hormone
17. Nerve growth factor
18. Epidermal growth factor
19. Insulin growth factor
20. Fibroblast derived growth factor

Section E

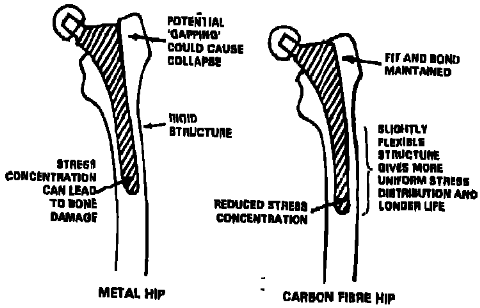
1. Thyroxine
2. Parathormone
3. Growth hormone
4. Oxytocin
5. Testosterone
6. Estrone
7. Melatonin
8. Insulin
9. Releasing factor
10. Epinephrine

Carbon-fibre Composites for Improved Orthopaedic Implants

Brian Jakes
Specialist Writer on Medical Technology

Problem fractures and hip-joint replacements in the elderly continue to present a challenge to the orthopaedic surgeon. Traditionally, metal implants have been used, but they are notoriously prone to fatigue failure and will not support weak bone structures indefinitely. However, a solution could be just around the corner. New generation carbon-fibre composites, developed primarily for the aerospace industry, could provide the answer to successful long-term orthopaedic implants. Trials of the composites have yielded satisfactory clinical results.

Two areas of orthopaedic surgery, particularly on elderly patients, are becoming commonplace, and yet cause maximum concern to orthopaedic surgeons. First is the treatment of problem fractures by implanting a screwed plate; the second is artificial hip replacement. Several factors may combine to cause a 'problem' fracture, for example, poor bone quality, failed previous surgery, soft-tissue injury, severe bone fragmentation and infection. After rigid internal fixation of the fracture by a metal plate, new bone tissue formation is inhibited



The rigid metal hip (left) suffers from 'gapping' and stress concentration, which can lead to early failure. But the flexible carbon-fibre hip (right) gives a more uniform stress distribution.

and bone union occurs extremely slowly. This means that it is often necessary to retain the plate for a year or more before the fracture is safely united.

Metal plates are notoriously prone to fatigue failure, and this, often combined with poor bone quality or fragmentation at the fracture, can cause the plate to become loose and so reduce its supporting function. In such cases, healing can only be assured by the addition of a bone-grafting operation.

Loosening and fatigue failure of artificial hips are also causes for major concern. Around 50,000 hip replacement operations are carried out each year in the UK, yet traditional metal hips can easily fail within 10 years of implantation. If an artificial hip fails and has to be replaced again, the second operation is always far worse and more traumatic than the first.

This trauma is often caused by the

surgeon having to break the cement used to fix the original implant, thereby removing good bone tissue and further weakening the hip joint. In fact, the limited life of metal hips discourages orthopaedic surgeons from doing hip replacement operations on people under the age of 60.

Fatigue Resistant

But thanks to the properties of new generation carbon-fibre composites, developed for the aerospace industry, othopaedic implant failures could be a thing of the past. Carbon-fibre composites may be structured in such a way as to be more resistant to fatigue than metal, and they are sufficiently elastic to allow some movement, thereby encouraging the formation of bridging bone-tissue and accelerating the healing time.

Britain leads the field in the exploitation of carbon-fibre composites for orthopaedic implants, and significant developments are taking place at universities, hospitals and medical centres throughout the United Kingdom.

Bio-engineer Dr John Bradley and his team at Orthodesign in Christchurch, southern England, have successfully produced carbon-fibre forearm, tibial and femoral fracture-plates and cementless artificial hips.

Made by hand-laminating layers of carbon-fibre with thermosetting epoxy resin, the fracture-plates have successfully undergone a series of clinical trials in the UK and abroad. In one such trial, patients admitted to the Department of Traumatic and Orthopaedic Surgery at Cardiff Royal Infirmary, Wales, with fractures of the lower femur were fitted with a contoured supracondylar carbon-fibre plate. This allows a small degree of movement at the fracture as the patient bears the weight, thereby stimulating the conditions necessary to promote new bone tissue growth.

Surgeons found the carbon-fibre plate simple to fit. Unlike many conventional methods of surgical treatment, a traction table was not required and an image intensifier became unnecessary. Furthermore, despite the fragmentation frequently found at the fracture, none of the patients required a bone graft at the time of plating.

In all, 22 patients were treated in a 27-month period, and within two months of plating, most had new bone tissue growth across the fracture. Functional bone union, defined as the stage when there was sufficient bone tissue to allow normal activity, occurred within five months.

There have been no reports of deep or superficial infections, implant failures and adverse clinical reactions to the carbon-fibre. Most important, the patients are now able to bear weight upon the fracture without pain or deformity .

In another trial at the University of Wales, College of Medicine, carbon fibre plates were used in the management of 19 tibial, ulnar and radial fractures. Early mobilisation was advocated, with no external splintage, and partial weight-bearing was encouraged for lower-limb fractures as soon as possible after the operation. The carbon-fibre plates were not removed after bone union.

In all cases, radiological union with satisfactory clinical results was achieved within 40 weeks, even though one patient, despite six operations, had previously suffered non-union of radius and ulnar for 12 years.

Revolutionising Design

Carbon-fibre composites are also revolutionising the design of artificial hips. Here, the short-term and long- term need to achieve stable transmission of 3-dimensional loading from bone-to-implant and back-to-bone is a must. Long-term survival of the implant/bone interface is dependent upon the biomechanical and biochemical compatibility and fatigue endurance of the implant as well as the health of the surrounding tissues. It is therefore essential that the configuration and mechanical properties of the prosthesis are designed to complement the normal bone structure.

Dr John Bradley's team at Orthodesign have spent 10 years developing and refining a cementless carbon-fibre hip which performs a lot better and is predicted to last a lot longer than the conventional metal hip. Carbon-fibre composites may be tailored to offer very high strength-to-stiffness ratio, so that the new hip combines high strength with controlled stiffness.

The rigid stem of the traditional metal hip causes 'gapping' at the top and stress concentration at the bottom, both of which are likely to lead to hip failure, sometimes as soon as 10 years after implantation. On the other hand, the less-rigid-carbon-fibre hip gives a more uniform stress distribution along the length of the hip, without 'gapping' so the hip should last much longer.

The team has implanted 30 carbon fibre hips in patients for clinical trials, and by using sophisticated measuring techniques, surgeons have found that these hips are working well. Carbon-fibre othopaedic implants are receiving independent praise from surgeons and patients alike. They are easier to fit, and outperform metal implants, even encouraging the growth of new bone tissue.

Carbon-fibre hip replacement are giving new hope to younger sufferers, because there seems to be no limit to their life. But carbon-fibre implants are not easy to mould into shape, and they currently cost twice as much as metal implants. However, cost is not a primary consideration when the fate on a limb is at risk. And as carbon-fibre implants become more widely used and go into mass production, their cost will come down significantly.

Courtesy : *Spectrum*

Images of Live Tissue Unlock Secrets of Life

WILLIAM COMET
LPS Special Correspondent

A team of British physicists has marked the centenary of the discovery of X-rays by breaking new ground in the development of the soft X-ray microscope, thereby radically improving the tools available to biologists to examine human tissue. For many years, medical researches have sought to observe live, 'wet' cells under the microscope, to help them understand more about such processes as cell division, a key factor in the development of ageing, and even other unpleasant conditions such as cancer.

The very powerful electron microscopes require the tissue being examined to be dried and stained on a slide for good images to be achieved. This means that the cells are effectively dead. By viewing these cells in the wet state, scientists can get a better picture of how cell division occurs in its natural, aqueous environment.

British physicists led by Professor Ron Burge at King's College in London and at the Cavendish Laboratory in Cambridge are now in the vanguard of research in the use of X-ray microscopy for examining wet biological cells. Professor Burge has pioneered the making and use of Fresnel zone plates for focusing X-rays onto sample tissue, a process thought to be impossible until about 15 years ago.

Further developments have now been made which will increase the resolution "to 10 nanometres (nm) by the end of 1996", according to Professor Burge.

This dimension is equivalent to the length of one hundred hydrogen atoms arranged along a string and far smaller than the linear size of a human cell. Such fine resolution represents an improvement by a factor of five compared with results achieved five years ago.

Concentric Rings

In the past, the method used involved employing a zone plate in much the same way as an optical lens to produce an image of the biological sample being investigated. The zone plate, smaller in diameter than the width of a human hair, differs from a lens in that it does not use glass and, instead, relies on a set of concentric rings drawn on a transparent membrane.

This means that the zone plate microscope is functionally analogous to the optical microscope. Glass lenses cannot be used to focus X-rays because glass does not refract X-rays. The zone plate on the other hand relies on a different principle, namely, the spreading of radiation by narrow apertures, which is known as diffraction.

In the new soft X-ray microscope proposed by Professor Burge, the configuration of the system is significantly more sophisticated than hitherto. The X-rays are produced by a giant electron accelerator, called the synchrotron.

The beam extracted from this machine along a pipe is focused down by a zone plate onto a system which consists

of a cantilever, bearing a small aperture lined with gold, and the specimen to be investigated immediately below it.

The aperture is only 20 nm in diameter (equivalent to the width of 200 hydrogen atoms), and the separation between the cantilever and the specimen is also 20 nm. The specimen's thickness should be between 200 and 300 nm.

The system works as follows : the gold-lined aperture, drilled with an ion beam, channels the beam from the zone plate into a narrow pencil of rays, which are then passed through the tissue.

The separation between the aperture and the specimen is monitored by reflecting a laser beam from the cantilever—bearing the hole—onto a detector. The surfaces of the cantilever and the specimen experience a force of molecular attraction, the magnitude of which varies according to the distance between these surfaces.

Laser Beam

At the same time, the X-ray pencil is transmitted by the tissue and is received on the other side by another detector. There are thus two signals—one of which measures and controls the separation between the aperture and the specimen, while the other is used to form an image.

The formation of the image relies on the fact that a greater thickness of specimen produces greater absorption of the X-rays, just as in an ordinary hospital X-ray photograph. Hence the variation in blackness across the picture.

The image produced by X-rays transmitted by the tissue is converted into a set of pixels which can be digitally processed and stored, eventually allowing it to be displayed on a computer screen.

Ultra-Narrow Aperture

The success of this system relies on the ability to maintain an extremely small separation between the aperture and the specimen, and on being able to produce the ultra-narrow aperture.

The former is in itself an indication of the surface topography of the specimen, while the latter produces a very fine pencil of X-rays, a factor controlling the resolution or sharpness in the resulting image.

All this requires highly sophisticated electronics and mechanical design which will eventually produce the required degree of resolution for researchers to actually see biological activity at cellular and biomolecular (sub-cellular) level.

"The best results from the old, existing soft X-rays microscope have achieved a resolution of 35 nm compared with 50 nm, about five years ago", says Professor Burge.

"With this totally new method—a complementary approach which is still theoretical, but which should produce results within 12 months—we expect to achieve 10 nm".

Rontgen, the discoverer of X-rays, would have been truly amazed by what his achievement has subsequently yielded.

COURTESY : *Spectrum*

Science News

Solar System to be Engulfed by Interstellar Cloud

Jeffery Linsky of the University Colorado reported that telescope readings taken in 18 different directions had found that the Sun and its planets are on the very edge of an egg-shaped cloud. Another cloud, he said, may be as near as 20,000 years away, although the distance is still uncertain. There will be an encounter.

When it happened it would change the flow of the solar wind—the particles that stream out from the Sun's corona — and could expose us to greater radiation. The Sun could also appear dimmer behind much thicker clouds of material. Both these effects could theoretically disrupt the weather on Earth, Dr. Linsky said.

For the past five million years—the time human life has taken to evolve on Earth—we have been moving through a volume of interstellar space that is practically empty. It cannot last, astronomers reported at a meeting of the American Astronomical Society. Some time in the next 50,000 years the solar system is likely to encounter much denser clouds, with effects that are difficult to predict.

Priscilla Frisch, a University of Chicago astrophysicist, explained that the solar system lay on an arm of the Milky Way galaxy and was rotating around it at about 60 light years every million years.

Within this part of the galaxy were stellar formations in which stars were living and dying creating vast clouds of gas and dust. Some of these clouds were expanding outward at high speeds.

Dr Frisch predicted that passage into a cloud of greater density would first change the heliosphere, the area surrounding the solar system that is under the influence of the solar wind. There could be dramatic effects on the inner solar system. The change heliosphere could cause an increase in cosmic rays striking the Earth, reshape the Earth's magnetosphere—which is the magnetic bubble that surrounds the planet—and possibly change the chemistry of the atmosphere.

How this would affect life on Earth was not known. Dr. Frisch mentioned however, that some researches had suggested that earlier ice ages might have been caused by the solar system passing

through interstellar clouds.

She said that interstellar clouds could have a bearing on where life could evolve in the universe. Stars that were passing in and out of dense clouds would have a highly changeable environment, a condition that might prevent the formation of fragile life. Without stability in the local stellar environment she doubted if there could be stable planetary climates hospitable to life.

Solar Upheavals Observed

The U.S. European solar space observatory, Soho has discovered jets of emission from the Sun that tell of violent action on the star, although it is currently in a quiet phase, the European space agency revealed in Paris.

Soho—the Solar and heliospheric observatory—was sent into space last December and is currently in an orbit from which it can permanently observe the Sun.

Short, hair-like jets of strong emission decorate the Sun's atmosphere to an extent not clearly seen before.

These 'spicules' of various kinds tell of energetic upheavals that may be responsible for heating the outer atmosphere to more than two million degrees centigrade. Also visible in the ultraviolet images are plumes like ropes, stretching far into space from the North and South Poles of the Sun, ESA continued.

Everyone is impressed by Soho's performance, said ESA science director, Mr. Roger Bonnet.

"By the end of the mission we shall know the Sun far better than we do now ... and we shall be able to comment".

Sclerosis is Linked to Genes

U.S. researchers said they had found regions in human DNA, believed to house genes that cause multiple sclerosis offering the best evidence to date that neurological disorder can be inherited, reports Reuter.

However, they stopped short of saying they expected to eventually find a single, MS - causing gene. The focussed, instead, on 19 separate regions in human DNA which all appears to 'contain genes that act in concert with other genes and with environmental factors, to being about MS.

The research as conducted by collaborating terms from Massachusetts general hospital, Duke University, the laboratory of the French Muscular Dystrophy Association and the University of California at San Francisco. The findings have been published in the August issue of "Nature Genetics".

The researchers studied the DNA in families in which at least two members had MS.

They mapped the DNA of the members of these families and tracked the segments that were shared in the same form by different family members.

One of the stronger associations identified was with a region on chromosome, six of human DNA that controls immune system regulation. That region was consistently found at a higher frequency among people with MS than in the population at large, the researchers said.

New Technique of Diamond Preparation

Florain Banhart and his colleagues working in Stuttgart's Max Plack Institute for Metal Research said that heating

the small balls of carbon onions to 700 degrees Celsius (1300 degree Fahrenheit) caused tiny diamonds to form in the core.

The transformation of graphite into diamond is of considerable technical interest, they wrote in the scientific journal *Nature*.

"We believe that our finding of a new way to convert graphite-like carbon to diamond could lead to a new understanding of the nature of the direct graphite-diamond transition".

In addition, the substances could have useful electrical properties, they said.

Diamond, the hardest substance known, is chemically inert and impervious to radiation damage. Scientists think it could be used in electronic components in severe environments such as space or inside nuclear reactors.

In nature it is formed when carbon, usually in the form of graphite, comes under intense pressure over time, as under the earth's surface. But diamond films can be produced using heat.

Breakthrough in Chemical Processing

Researchers at the National Chemical Laboratory (NCL) having found an improved way to produce zeolites, a family of chemical facilitators.

The breakthrough came when a team of scientists led by Dr Rajiv Kumar of the Pune-based research institute found that the formation of zeolites can be hastened several times by adding a cocktail of inexpensive chemical compounds.

Though these shape-selective wonder catalysts have been in use in petrochemical and other chemical industries for decades, their crystallization is notoriously slow and requires relatively high temperatures.

"It seems we have found a new method that cuts short the time required for zeolite crystallization substantially", Dr. Kumar said. Their findings appeared in a recent issue of the prestigious international research journal, *Nature*.

The NCL team comprising Dr Asim Bhoumik, Dr Ranjeet Kaur Ahedi and Dr Subramanian Ganapathy besides has already filed patent applications for the technique in India and the USA. The proprietary technology, once industrially acceptable, will be a money spinner.

"It is an exciting breakthrough with tremendous potential for industrial applications", says Dr R.A. Mashelkar, the chief of Council of Scientific and Industrial Research.

Zeolites (boiling stones in Greek) are a group of white or colourless alumina-silica based minerals with characteristic crystal structures that occur in nature.

Until the 40s, zeolites were like any other chemical compound and aroused very little scientific curiosity. However, the discovery that some of these crystalline compounds can be good catalysts in industrial chemical processes started a rat race to synthesize new zeolite materials with improved properties or newer applications.

NCL which has many zeolite technologies to its credit is among the five top zeolite research groups in the world.

Increasing use of zeolites in industries has naturally boosted the demand for theses materials, whose crystallization was painfully slow. Depending on their composition, the time taken for

zeolite formation ranges from one day to one week.

According to Dr Kumar, the significance of the work done by NCL is that its speed up the crystallization of several types of zeolites, resulting in increased yield and substantial savings in energy and cost.

Besides, the new finding is expected to throw light on how zeolites are formed in nature, an area which remained largely ambiguous during the 50 years of zeolite research.

Combating Dengue by Genetic Method

With efforts to develop a vaccine against dengue and eradicate mosquitoes failing, scientists at the Colorado State University in the USA have tried a novel strategy by genetically engineering mosquitoes so that it can no longer carry the virus.

A team, led by E.K. Olson, injected mosquitoes with a Sindbis virus that can block replication of the dengue virus in the salivary glands of the mosquitoes.

Dengue viruses, which have spread from their original home in Asia to tropical Americas, are carried by Aedes Aegypti mosquitoes which 'eed on and infect humans.

The virus enters female mosquitoes when they bite infected humans, and multiplies inside the mosquito, spreading to all parts including the salivary parts including the salivary glands. The virus in the mosquitoes' saliva is again transmitted to a human on biting.

Dengue infections usually result in flu-like symptoms with mild fever, but sometimes cause a dangerous haemorrhagic fever called Dengue Shock Syndrome.

Progress in Treatment of Alzheimer's Disease

Jeremy Lawrence, Science Correspondent, reports in the *Times London* that scientist are on the threshold of developing treatments that will slow the ageing of the brain and the onset of dementia, which has become the scourge of old age across the western world.

In Britain, 650,000 people are currently affected by Alzheimer's disease and the number of sufferers rises with age from one per cent of those aged between 60 and 65 to 20 per cent in age group of 85 and above.

Among the drugs being investigated are anti-inflammatories given to people with arthritis, anti-ulcer drugs such as Zantac and anti-oxidants such as Vitamin E.

New evidence suggests that Alzheimers is linked with an inflammatory response in the brain and 14 studies in the USA have shown that patients treated with anti-inflammatory drugs have a reduced risk of developing the condition. Similar observations in patients taking anti-ulcer drugs which block H2 receptors have led to the discovery of the same H2 receptors in the brain. These are linked to glutamate receptors which have a role in maintaining cognitive function.

Women taking HRT have delayed the onset of cognitive decline and Nerve Growth Factors discovered 30 years ago have been shown to play a role in Alzheimer's.

Professor Jim Edwardson, of the In-

stitute for the Health of the Elderly at the University of Newcastle, in the north of England, said academic researchers and the pharmaceutical industry were engaged in a 'massive mission' to find treatments for the condition.

"If we could slow the onset of dementia by five years we will halve the number of people affected. Within the next decade we will see a significant move towards the introduction of new therapies which will slow or arrest the onset of the disease", Prof Edwardson said.

He said drug companies had dozens of drugs in trials where 10 years ago they had none. "If these were all novel drugs I would be more cautious. But we can be fairly confident that amongst the plethora of therapeutic strategies being investigated, although some will have only a modest effect, cumulatively their effect will be very significant", he said.

UK Scientist Create Synthetic Bones

A synthetic bone developed by British scientists that promises longer life than current artificial implants and which can be trimmed to shape at the last minute by surgeons, is about to be launched as a middle ear implant after approval by the Food and Drug Administration, reports the Reuter News Agency.

Used as a middle ear implant alone, the market for the material is estimated to be worth $36 million within the US and twice as much globally. This was announced by Professor William Bonfield, London University, at the British Association Festival in Newcastle.

According to Prof Bonfield, Smith & Nephew plc, whose US unit is to market the ear implant, expects to take half of the US market. The next anticipated use of the new bone material is for repairing facial bones after accidents or diseases such as cancer. But the substance, developed with the help of government funding at Queen Mary and Westfield College, London, could eventually be used throughout the body. "It is the tip of the iceberg", said Prof Bonfield to a news conference after giving a paper on the discovery. He said that the material was tailor-made to mimic human bone. As a result, it avoided the problems of current implants like artificial hip joints. "What we have produced is a smart material. It is 'seducing' the (original human) bone, so bone will grow right up to the material," informed the Professor and added: "There is no problem with rejection. It could be used to replace any bone in the body".

COURTESY : *Spectrum*

Improved Treatment of Lung Cancer

Scientists at England's Imperial Cancer Research Fund have worked for more than 15 years to develop the new treatment which will block the action of neuropeptides, the molecules responsible for malignancy in lungs, says a British medical report.

Neuropeptides are a type of hormone that dock onto cells at special points known as receptors and send signals that can lead them to multiply out of control with uncontrolled growth that characterizes cancer.

Dr Enrique Rozengurt, who led the

research, explains "what we have done is discover ways of blocking these growth factors using antagonists, these are look-alike agents that themselves dock onto the receptors, getting in the way of growth factors. We have identified a group of antagonists that can block every type of growth factor with a particular type of signal".

Scientists feel that the treatment will lead to improved survival of lung cancer.

While chemotherapy is highly effective in eradicating cancer cells, the disease returns in more than 90 per cent of cases and drugs do not work a second time.

The new treatment would be used as a follow-up to initial chemotherapy to prevent the cancer cells regrowing.

Social Shrimps Found

Marine biologists said they had found a breed of shrimp that live in colonies like ants or bees with a 'queen shrimp' and workers shrimp who defend the colony.

The shrimp, know as snapping shrimp because they have a claw they use for defence, cooperate in feeding their young and show the same altruistic behaviour as termites, the report in the science journal, Nature said.

They are the first marine animals to be found living in social colonies.

"The sponge-dwelling shrimp *Synalphus regalis* lives in colonies that may have more than 300 individuals, but that contain only one reproductive female," Emmett Duffy of the College of William and Mary in Gloucester Points, Virginia, and colleagues wrote.

European Lineage Analysed

The analysis, published in the "American Journal of Human Genetics", coming from a team led by Dr Bryan Sykes of the Institute of Molecular Medicine at Oxford and including scientists from Hamburg, University, Colleges, London, Plymouth, and Newcastle concludes that Europeans are descendants of hunter-gatherers who first colonized the continent 40,000 years ago.

The scientists examined samples of DNA from populations across Europe, obtained from hair roots or blood samples. The form of DNA they studied—mitochondrial DNA—is passed down only through the maternal line and mutates at a known rate.

From the amount of variation in this type of DNA in a population it is therefore possible to work out the length of time that has elapsed since that population originated.

The team found that the DNA in their samples could be classified into five broad groups, each with an origin at different times. The oldest group appears to have originated some 50,000 years ago, the youngest about 6,000 years ago.

By far, the commonest groups, accounting for some 70 per cent of the variations found in today's Europeans, date back considerable earlier than the invention of agriculture 10,000 years ago.

This suggests, say the authors, that the bulk of Europeans are descended from people who were here before the farmers began to arrive. There appear to have been two phases : first the colonization of Europe up to 40,000 years ago and then a rapid expansion of population about 25,000 years ago, which may have been caused by new immigration or by a warmer climate .

The results indicate that agriculture came to Europe by a process of education rather than population displacement. The hunter-gatherers learned to cultivate crops from the incoming wave of farmers, but were not replaced by them.

These two groups then inter-bred, producing today's population mix. As for the Neanderthals, they neither learnt from the in-comers nor bred with them, losing out to modern man and being replaced totally by him.

In Search of New Fossils

Fossil of Strange Creature

British scientists said that they had dug up the fossilof a strange creature that lived 450 million years ago and had never been seen before by humans.

The creature, nicknamed Sue, lived in cold, shallow seas in what is now South Africa.

"It's very weird", said Richard Aldridge, a palaeontologist at Leicester University, who led the expedition. "It's got a lot of characteristics like arthropods. It might be a distant relation of prawns or something like that. But it also looks like worm".

A layer of fossilized mud, known as the zoom shale, has turned up many such finds in the Cedarberg mountains north of Capetown.

Children Find Fossils

Two Australian children sifting through rocks and dirt in Australia's outback, have detected one of the world's most important fossil treasures, Australian fossil experts said yesterday.

The fossils prove that amphibians lived here 330 million years ago and indicates that Australia could be the place where fish first crawled out of the water and land-based life began, the Queensland University researcher, Mr. Tim Hamley, said.

Leading British scientific journal, "Nature", this week published the findings of the Queensland University zoologist, Mr. Tony Thulborn, his colleague Mr. Hamley, and two other researchers.

"The fossils find is significant because it shows that direct descendants of the current form of tetrapods— amphibians, birds, reptiles and mammals—were distributed throughout the southern as well as the northern hemispheres", Mr. Hamley said".

Fossils of Forest Animals in Peruvian Desert

A group of French scientists said that they had found the fossil of a prehistoric horse that roamed the Peruvian coast up to 23,000 years ago.

The scientists discovered the fossils as they scoured the coastal desert around Trujillo, 570 km north of Lima, while searching for clues about the region's first human inhabitants.

The group has also discovered incomplete fossils of an elephant-like Mastodont, a fox and a deer which lived in the area 4,000 years before the first humans, said anthropologist Claude Chaucat.

"According to our investigations there seems to be no connection between the animals and humans", he said.

While Peru's coastal strip is now a desert, in prehistoric times it is thought to have been covered with vegetation, he added.

Book Review

Fundamentals in Mathematics

By P.N. Arora, Class XI, Price Rs. 95; Class XII, Price Rs.140, publisher Sultan Chand & Company.

Fundamentals in Mathematics is authored by P.N. Arora and published by Sultan Chand and Sons. The books with same name are published differently for Class XI, and Class XII. The books are written for +2 level and are strictly according to the CBSE syllabus.

The ideas borne in mind by the author are to present a book with a simple lucid language and provide as many solve and unsolved questions possible for the practice of subject. Throughout the book, the problems have been graded for weak, average and bright students. Typical problems are added for above average students to enable them in competitive examinations like IIT, JEE, NTSE etc.

In the book for Class XI, the course is adequately covered in 14 chapters and 4 appendices. The chapters include topics like Sets; Relations and function; Trigonometry; Complex Numbers; Quadratic Equations; Sequence and Series; Permutation and Combination; Induction and Binomial Theorem; Exponential and Logarithmic Series; Coordinate Geometry and Linear Programming. Amongst the appendices, appendix A has 175 typical problems to test the 'wits and reasoning' of the student..

In the book for Class XII there are 11 chapters covering topics like Matrices and Determinants, Functions, Limits and Continuity, Differentiation, Derivatives, Integration, Differential Equations, Vectors, Three Dimensional Geometry Probability, Binomial Distribution, Correlation and Regression. In the chapter on Probability, Bayes' theorem is not included though it is an integral part of +2 course. The book also includes questions asked in Haryana, Punjab Board examinations where +2 course is followed.

There are certain lacunae in printing though the author says that all printing mistakes have been weeded out, many printing mistakes mar the quality of the book. As in the book for Class XII, page 8.29 have *product* written as Roduct, Figure on page 8.4 is printed upside down, Figures on page 8.5 are not clearly visible. Page 8.21, 8.17 have mistakes in questions (... of a vector $X^3 - X^1\ X^3$ is never mentioned in rest of questions). In the book under review pages 8.27, 8.30, 8.34, 8.35, 8.38 and 8.39 are all blank with no printed matter.

The book for Class XI is superior in quality of printing than Class XII.

The books are considerably economical looking into the quality and quantity of questions offered to a student and amount of efforts made by author. The books may fill the gap between the 'lip and the cup' and help the student to understand those things he thinks he knows but during examinations, ...mistakes.

B. Deokinandan
Reader
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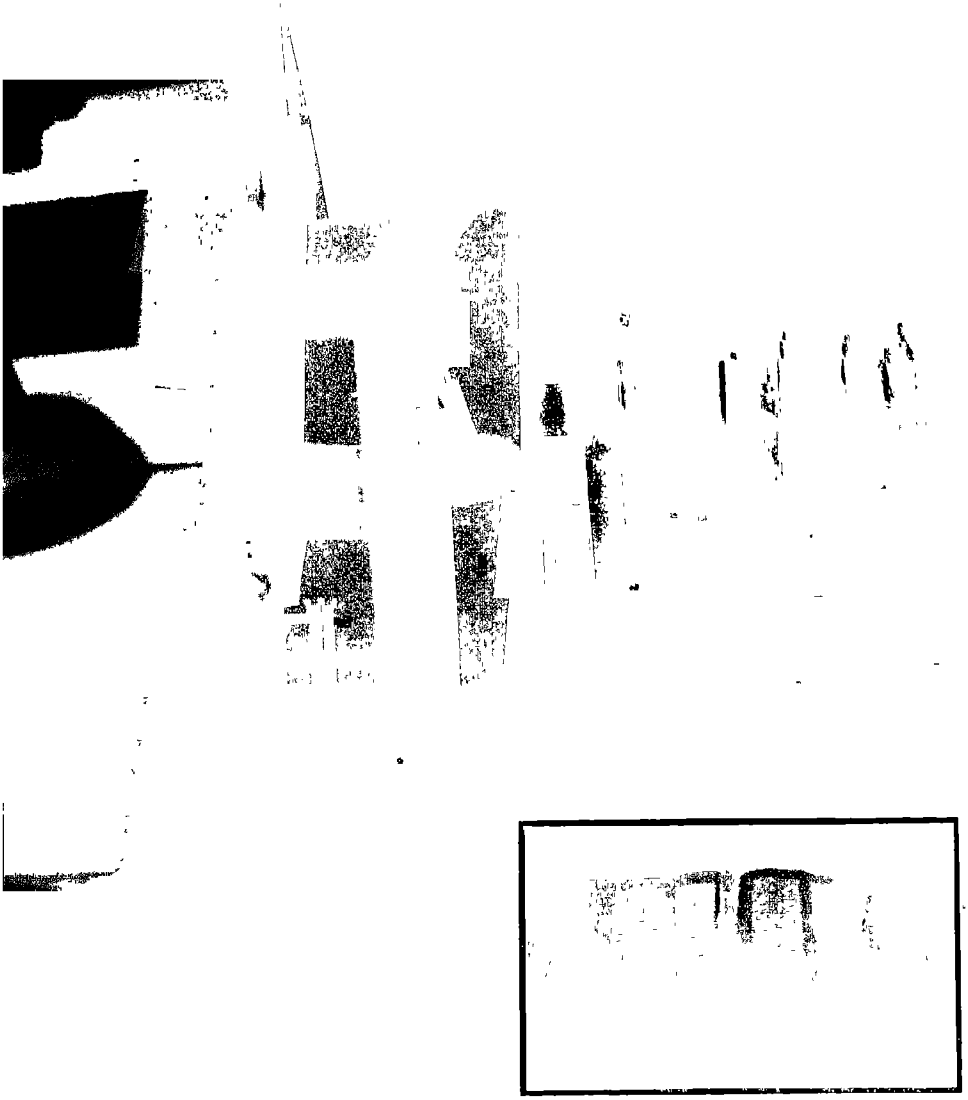
SCIENCE RELATED VALUES

Curiosity, quest for knowledge, objectivity, honesty and truthfulness, courage to question, systematic reasoning, acceptance after proof/verification, open-mindedness, search for perfection and team spirit are some of the basic values related to science. The processes of science, which help in searching the truth about nature and its phenomena are characterised by these values. Science aims at explaining things and events. Therefore to learn and practise science :

- **Be inquisitive about things and events around you.**
- **Have the courage to question beliefs and practices.**
- **Ask 'what', 'how' and 'why' and find your answers by critically observing, experimenting, consulting, discussing and reasoning.**
- **Record honestly your observations and experimental results in your laboratory or outside it.**
- **Repeat experiments carefully and systematically if required; but do not manipulate your results under any circumstance.**
- **Be guided by facts, reasons and logic. Do not be biased in one way or the other.**
- **Aspire to make new discoveries and inventions by sustained and dedicated work.**

SCHOOL SCIENCE

DECEMBER 1996



SCHOOL SCIENCE is a journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims at bringing within easy reach of teachers and students the recent developments in science and science methodology, and serves as a useful forum for the exchange of readers' views and experiences in science education and science projects

Articles suitable to the objectives mentioned above are invited for publication. An article sent for publication should normally not exceed ten typed pages, and it should be exclusive to this journal Illustrations should be drawn with pen and indelible ink Photographs (black and white), at least of postcard size, should be on glossy paper and should be properly packed to avoid damage in transit

Manuscripts with illustrations, charts, graphs, etc along with legends, neatly typed in double space on uniform sized paper, should be sent to the Executive Editor, SCHOOL SCIENCE, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi 110 016.

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CONTENTS

TO OUR CONTRIBUTORS

JIE invites articles/papers on the impact of educational research on classroom practices and policy decisions. Specific examples where this impact is apparent may be given.

— ACADEMIC EDITOR

Simulation of Alpha Particle Scattering Experiment

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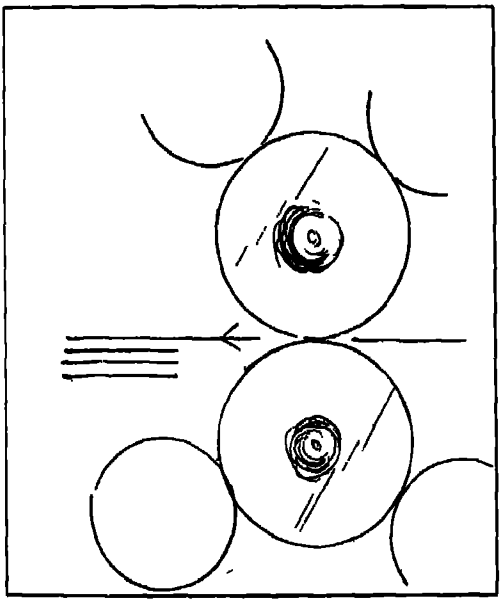

The present day model of the atom consisting of a very small nucleus, in which most of the mass of the atom is concentrated, surrounded by electrons which occupy a larger volume was given in 1911 by Ernest Rutherford based on his popular alpha particle scattering experiment. During that year, Rutherford with his two associates, Hans Geiger and Ernest Marsden carried out this experiment in which high energy positively charged particles (alpha particles) were bombarded on thin foils ($4x10^{-6}$m thick) of heavy metals. The alpha particles were obtained from the disintegration of radium or radon. These are the nuclei of helium atoms. They can travel several centimetres through the air or approximately 0.1 mm through the solids, before they are stopped by collision with atoms.

Rutherford observed that when the alpha particles were bombarded on a thin gold foil, most of these particles passed through the foil and only a few deflected back. Some of the alpha particles that passed through the gold foil were deflected at different angles. Most of the deflections were at very small angles. However, some of the alpha particles were deflected by large angles. Some particles were deflected even by 180° i.e. they were bounced back towards the source. These observations could be explained by considering that most part of the target i.e. the atoms of gold is empty space and the mass and positive charge of an atom are concentrated at one point, known as the nucleus of the atom. The size of the nucleus is very small compared to the overall size of atom. Since most part of the target is empty space, majority of the alpha particles directed away from the nucleus, pass through without any deviation and the angle of deflection is zero. But when an alpha particle approaches close to the nucleus, the repulsion of two positive charges the alpha particle and the nucleus causes the alpha particle to deviate from its straight line path. The

deflection depended on how close the alpha particle approached the nucleus. If an alpha particle approached directly to the nucleus then it gets deflected by 180°.

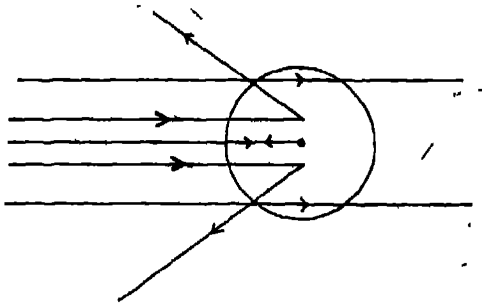

FIG.1

From this scattering experiment, Rutherford was able to conclude that the cross-sectional area of the nucleus is 10^{-8} times the cross-sectional area of an atom of gold[1]. Hence the ratio of the diameter of the nucleus to the diameter of the atom is the square root of 10^{8} i.e. it is $(10^{-8})^{1/2} = 10^{-4}$. Since the diameter of the atom as revealed from x-ray investigations is about 10^{-8} cm, the diameter of the nucleus is about 10^{-12} cm.

The students of senior secondary stage find it difficult to comprehend Rutherford model of the atom based on scattering experiment. They even fail to visualise as to how could the size of the nucleus be determined from scattering experiment. Also, it is not possible to perform the actual alpha scattering experiment in the class due to the involvement of hazardous radioactive materials As the scattering experiment and the conclusions derived from it are highly abstract in nature, their comprehension by the students requires the use of some concrete situations or simulations[2]. One way is to perform the actual experiment and calculate the size of nucleus from the experimental data. The use of simulation technique has been found beneficial in such cases. Although simulations have their own limitations by not reproducing the actual situation, but they may help to a greater extent in learning the concept.

A few simulation experiments have been proposed in the literature[3,4,5]. In one of these, marble balls (alpha particles) are rolled at a perpendicular direction towards a set of marble balls (atomic nuclei) spread along a straight line on a table between two metre sticks as side boundaries. Each time a marble is rolled it may or may not hit the target i.e. the marble arranged in a straight line. The data of the number of targets, the number of hits, the number of times the marble is rolled and the distance between two side boundaries, are collected. From this data the radius of target marbles could be calculated. In this experiment, whenever the target marble ball gets hit, it had to be rearranged by hand before the next roll. In the design of simulation proposed by Bishop[6], the target balls are hanged with thread. After 2-3 hits, the target balls often get detached of the thread and have to be glued again and again. Secondly, every time the projectile ball hits the target ball, it gets displaced from its position. It gives the impression as if the nuclei of atoms get displaced when hit by alpha particles which is not so. Also in this design of experiment, one has to wait for the target ball to come to the normal position before the next roll.

In the present simulation experiment, we have utilized the design proposed by Bishop[6] with certain modifications and performed the experiment to determine the size of target marble-balls. The diameter of the balls as determined from the experiment is close to their actual diameter. The experiment enables to help students to visualize

as to how Rutherford was able to determine the size of nucleus based on the frequency of deflections of alpha particles due to the influence of nuclei at atoms.

Desoription of Equipment

The equipment consists of an inclined platform made of plywood. It is about 29 cm wide and 40 cm long. The vertical height of the lower of and upper side of the inclined plane has been kept about 15 cm and 25 cm respectively. This gives an adequate slope for the projectile balls to roll.

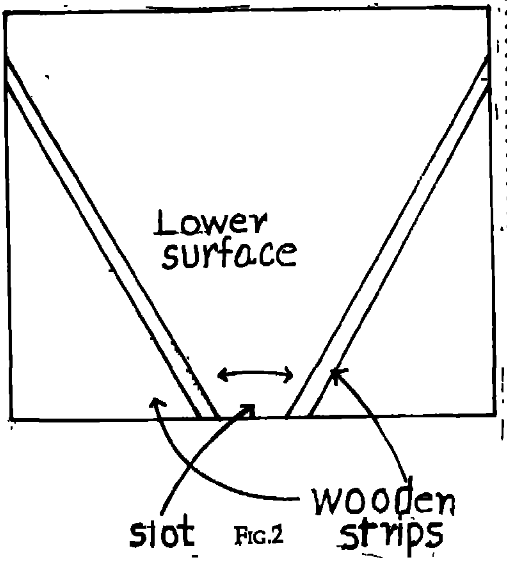

FIG.2

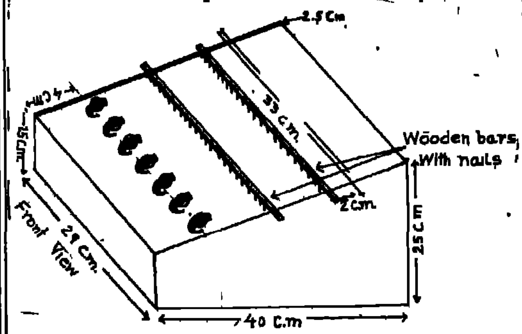

FIG.3

The top inclined surface is about 2.5 cm below the top sloped edges of the two sides. There is another inclined plane fixed near the bottom with its inclination in the opposite direction. It is referred to as the lower surface. It is attached to the sides and the front plate. The width of lower surface is equal to that of top surface. It has a slope in the opposite direction to the slope of side edges. Two wooden strips are fixed (Fig.3) on the lower surface to direct the projectile balls to return back through a narrow slot for their convenient collection. A removable block of wood or any other materials is placed across the slot to plug it temporarily. A gap of about 4 cm is left between the top inclined surface and the front side so that the projectile balls come down to the lower surface after rolling on the top surface. Once a ball comes down to the lower surface, it rolls back to the experimenter. Two to three wooden bars with nails fitted in them are used to ensure the randomness of each roll. These bars are about 33 cm wide and 2 cm thick. These are about 4 cm longer than the width of the platform. Each bar has slot on both sides for sliding them on the top side edges. About 3.5 cm long iron nails are driven into the bottom surface of each bar 2.5–3 cm apart in a zigzag manner. Heads of all the nails are then cut-off such that about 2 cm of the nails are left exposed. These scrambler bars are kept on the top side edges (Fig.2) and in between the target-balls and the experiment. The position of bars can be shifted. They also prevent direct hits of the target balls. The target-balls are held to the front edge of the top surface with the help of bent iron-strips/clips. Sufficient gap is kept between the target balls so as to allow free passage for the projectile balls i.e. without touching target balls. Thirty-five marble balls of approxi-

mately the same diameter are required in the experiment. Of these 5-7 balls are fixed as target balls at the lower edge of the top surface with the help of iron-strips The targets are spaced uniformally. Rest of the marble balls are used as projectiles. Use wooden strip of about 4 cm width and 2 cm thick to decrease the width of the top surface.

Procedure

Fix seven marble balls as targets to the lower edge of the top inclined surface with the help of iron clips with a uniform space between them. The space between the two targets should be enough so as to allow the free passage of projectile balls. Put two scrambler bars with their slots on the two top side edges. Take 25 projectile balls and release them one at a time at different positions on the top of the inclined top-surface. The projectiles roll down through the scrambler bars towards the targets. A particular roll may or may not hit the target. The positions of scrambler bars are changed after every five rolls. The number of hits in every 25 rolls are counted and recorded. The projectiles are collected and the experiment is repeated using the same 25 projectiles. The experiment may be repeated with 250 rolls of projectile-balls.

The number of target balls are changed from 7 to 6 then to 5 and the experiment repeated again for 250 rolls. Then the width of the top inclined surface is changed using the wooden strips. Again the experiment is repeated using 7, 6 and 5 target-balls respectively.

Radius of a Target Ball

Let the radii of a projectile and a target ball are R_p and R_t respectively. A projectile ball will hit the target ball only when the distance between the centres of two balls is less than the sum of their radii $(R_p + R_t)$ Since a projectile can pass on either side of the target, the total distance of collision path is $2(R_p + R_t)$. The probability of a projectile hitting a target is directly proportional to the collision length $2(R_p+R_t)$, and to the number of targets (N) but inversely proportional to the width (d) of the inclined surface available to roll down of projectile balls.

$$\text{Probability} = \frac{2(R_p + R_t)\ N}{d}$$

Probability is also the ratio of the number of hits (H) to the number of trials (T)

$$\text{Probability} = \frac{H}{T}$$

Thus

$$\frac{H}{T} = \frac{2(R_p + R_t)\ N}{d}$$

Since $R_p = R_t$

$$\frac{H}{T} = \frac{4R_t\ N}{d}$$

$$R_t = \frac{H \times d}{T \times 4N}$$

The radius of target marble balls is calculated using the experimental data. Also, the average radius of target balls is determined by placing them in a row and measuring the total length. This length divided by total number of marble-balls gives the diameter of one ball. The radius of a ball is half its diameter. Compare the radius of a target ball with its actual radius.

The data collected for two different width of the top inclined surface is given in Tables 1 and 2.

TABLE 1
(Width of top inclined surface = 29 cm)

Number of Targets (N)	7	6	5	7	6	5
No. of Scrambler bars	2	2	2	3	3	3
Projectiles			*Hits*			
1st 25 Rolls	20	11	13	18	18	13
2nd 25 Rolls	22	13	13	17	16	14
3rd 25 Rolls	17	13	17	21	13	12
4th 25 Rolls	16	15	11	23	17	12
5th 25 Rolls	19	16	13	18	13	17
6th 25 Rolls	19	13	16	20	19	13
7th 25 Rolls	19	16	15	15	15	16
8th 25 Rolls	17	16	18	19	16	16
9th 25 Rolls	17	13	11	19	16	9
10th 25 Rolls	15	17	12	16	16	17
Total 250	181	143	139	186	159	149
Calculated R_t (Cm.)	0.745	0.652	0.797	0.767	0.768	0.855
Average R_t (Cm.)		0.731			0.796	

TABLE 2
(Width of inclined Surface = 24.3 cm)

Number of Target (N)	5	5	5
No of Scrambler bars	2	2	2
Projectiles		*Hits*	
2nd 25 Rolls	19	13	14
2nd 25 Rolls	18	15	16
3rd 25 Rolls	14	11	15
4th 25 Rolls	14	17	16
5th 25 Rolls	14	15	18
6th 25 Rolls	15	15	13
7th 25 Rolls	20	14	19
8th 25 Rolls	14	13	16
9th 25 Rolls	12	16	16
10th 25 Rolls	12	18	15
Total 250	152	147	158
Calculated Rt (cm.)	786	.733	.767

$$\text{Actual radius of one Target Ball} = \frac{7.65}{10}$$

$$= 0.765 \text{ cm.}$$

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Environmentally Sustainable Development and Education

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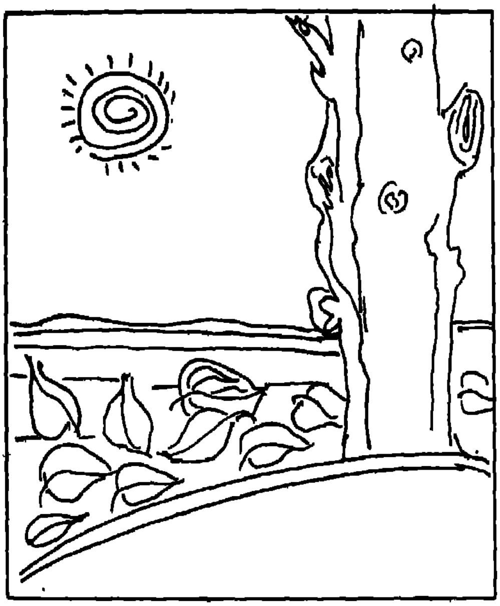

Any list of basic human needs, past, present or future, would include food, shelter, health and safety as survival needs; education, employment and possibly some form of industrialization as development needs, wealth, security and growth as perceived needs. Of course, man does not live by bread alone. Human needs go beyond the purely physical and are immersed in social and economic environment as well. Humans need meaningful education, employment, leisure time, and the human qualities of respect, care and affection. Deprived of these a person may languish just as surely as if deprived of food and water.

Most of our physical needs demand access to natural resources such as land, water and air, which, with the aid of radiant energy from the sun, generate plants and animals the so-called renewable living resources. Non-renewable resources such as minerals and fossil fuels are, of course also needed for human survival and development. All these resources are to be found on a thin layer of the earth's surface known as the biosphere and have been exploited for the benefit of the mankind with the advancement of scientific knowledge and advent of modern technology. It is the physical environment in which we live. The linkages between the science, technology, environment and human needs are therefore clear.

Science and Technology

Technology unlike science, deliberately sets out to create things that satisfy human needs. It has been said that science explains what is and technology creates that never existed before. Technology has always generated devices and procedures, often exhibiting great creativity, to do things which serve useful ends.

The human beings have achieved tremendous power through technology, to alter the physical and chemical composition of the natural resources of the earth.

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Modern civilization has made the environment more livable in many ways. Since the invention of soap and the first understanding of modern medicine, we have developed better health care and consequently people are healthier. We have learnt to feed more people better than ever before, and more of us can travel further to see national parks and enjoy outdoor recreation that was not possible in the past.

Man, because of his intelligence and science, is changing the environment and has become the major force in the transport of solid earth materials. The chemical by-products have resulted in major changes in the hydrosphere and atmosphere. The human being, although part of living organisms, have, through the use of science and technology, so altered its life support systems that all living things including man himself are threatened with disaster or extinction — if present trends continue — either through the relentless impact of an exponentially increasing human population— already beyond the 4000 million mark — or as a result of man-made nuclear holocaust. That is, if disasters like the Chernobyl explosion or the Bhopal gas leak are to be avoided, science and technology should be in phase with the ecological concerns. There is, need therefore, for an ecologically-oriented science and technology education to contribute its share to a reversal of these trends while there is still time.

As development speeded up with the growing demands, the requirements of the people were met. But earlier the need for conservation, concern for environment etc., were not realized. It was when a few handful felt the alarming situation leading to environmental degradation that the whole world became aware of the importance. Global issues of pollution, population, degradation and conservation were started being regarded all over the world.

Whether the positive benefits of technology out-weigh the negative ones in the long runs is an open question. We have many choices, but these choices can lead us in one of the two directions. We can move forward to a future in which we live in harmony with our environment, maintaining our renewable resources and judicially using our non-renewable ones. (The biogas plant could be quoted as an example of intermediate technology. It uses a renewable resource in probably the best possible way.)

Or, we can act in ways that will lead to an impoverished landscape, with its problems of pollution, the loss of resources, the exhaustion of soils, forests and fisheries and the extinction of many important species. Our choice of direction depends on our knowledge and understanding of the environment.

It is sad that in country after country, progress has become synonymous with an assault on nature. We, who are a part of nature and dependent on her for every need, speak constantly about 'exploiting' nature. When the highest mountain in the world was climbed in 1953 Pandit Nehru objected to the phrase 'conquest of Everest' which he thought was arrogant. Edward Thompson, a British writer once told Gandhiji that wild life was fast disappearing. Gandhiji remarked 'It is decreasing in the jungles but it is increasing in the towns'.

Emperor Ashok defined a King's duty as not merely to protect citizens and punish wrong doers but also to preserve animal life and forest trees (Annex 1).

Must there be conflict between technology and a truly better world? Consideration of human needs presume that we must ac-

tively seek ways to improve the quality of life. This implies dealing with values in our education, even in science and technology education.

So far we talked about the basic human needs which gave rise to scientific and technological development the negative aspects of which generated a concern for environment. Let us first look into the meaning of environment before discussing its problems and their solutions.

Environment

Environment is a particularly variable term. In its broadest sense it is aggregate of conditions surrounding and influencing an organism or group of organisms. Since the 'conditions' interact in complex ways, this definition leads to an inclusion of all of the earth's resources, plants and animals (including people). It results in the 'spaceship earth' concept, which is a useful one for considering global problem such as the ozone hole and greenhouse effect. The individual is concerned with that portion of the environment that effects him directly in terms of health, risk to life and limb, risk to livelihood; and sometimes the more abstract quality of life. His concern extends to the immediate family and often to the community. Thus, the personal definition, and one that extends upwards, is of an environment of air and water quality, noise, and the conditions of natural resources.

Human culture depends on the availability of certain vital resources which are gathered, processed, utilized and sometimes discarded in various ways. The basic ones are described below:

Air

Air is usually taken for granted, since it is in the greatest sense a common property. It is always abundant, but not of the desired quality. Even an activity that does not actually consume air as a resource may degrade it so as to make it marginally usable for other important purpose, such as breathing.

Water

If there is a single resource universally required for life it is water. The very nature of its distribution, its ability to alter its quality in myriad ways, and the variety of requirements for its makes water the centre of more disputes than any other resource. Naturally water development programmes and projects are likely to produce more intricate social and environmental problems than those of any other resource.

Land and soil

The characteristics of the land are such that it may be dictated or denied by topography, area, elevation, texture, chemistry and, the relationship to other resources. For convenience, minerals and fossil fuels may be considered land resources. Of all the resources man's dependence on land, is perhaps the most difficult to augment and the easiest to degrade.

Energy

There are renewable and non-renewable energy sources, either of which may provide transportable energy. Most energy ultimately is solar energy, whether stored, as in wood, coal, petroleum, and other combustible, as kinetic, as in hydroelectric power. Most rural and many urban populations depend on renewable energy for heat and locomotion. Whatever its form, energy must be stored, transported and released in a particular way in order to be useful. Due to ever increasing de~ ands of these natural resources and o~ xploitation by

modern technological advances these get polluted and become unfit for use by living beings.

Environmental Degradation

Due to increasing human activity there is continuous environment degradation. Water and air pollution, deforestation and consumption of non-renewable resources are some of the major concerns. Certain environmental issues have health implications on a wider scale than the local or national level. They include the long range transport of air pollutants, the transboundry movement of hazardous products and wastes, ozone depletion, climatic change, ocean pollution and loss of bio diversity.

It is reasonably obvious that a primary cause of environmental problems is excessive population and its rapid and continued growth. Every extra person is to be fed, clothed and housed. The increasing human population requires immediate increase in production. This forced to rely on successively more intensive agriculture and the consequent use of fertilizers, pesticides, herbicides and other modern techniques which result in increasing strain on the ecosystem and can, in the absence of sufficient care, lead to deterioration in the quality of soil, water and forests.

The environment is degraded through the process of economic growth. Modern agriculture, industry, urbanization, energy production and its consumption and transportation, all produce a vast array of wastes, which are dumped indiscriminately into the soil, water bodies and air presenting hazards not only to health, but often to life itself. Excess salinity in the soil, pesticide residues and dangerous chemicals in water and soils, toxic gases and smoke in the atmosphere are just a few examples of the pollution problems.

There are the environmental problems caused by the actions of others, such as man induced changes in the climate, the rapid distribution of pollution, the disposal of wastes into river waters. Impoverished immigrants live in the unhealthy surroundings of squatter settlements because society has not made adequate provisions for work in the home communities. Economic incentives are sufficient to draw them into the city but not enough to provide them a reasonable livelihood.

By the middle of this century, a truly international environmental movement emerged which was aided by several peripheral development — such as

(a) Increasing concern over world population growth, bringing increased awareness of the finite limits on global resources;
(b) The expanding nuclear power industry, linked in the public mind the terror of nuclear war ; and
(c) Several key publications highlighting the environmental problems directly to the public eye. Keeping these developments in view, and based on the decisions taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972 (in which India also participated) Parliament of India enacted "The Environment Protection Act, 1986" and its modifications in 1994 (Annex 2 and 3)

Sustainable Development

Development is necessary to meet the increasing demands of ever growing population and also for improving the quality of life. Any development process is likely to have some adverse impact on environment. Sustainable development therefore

means development without or with minimum adverse impact on environment.

Environmentally sustainable development and management implies :

(a) development to be managed in such a way as to ensure that resources are conserved and/or restored, and that beneficial environmental effects are maximized while adverse effects are ameliorated to the extent possible.
(b) efficiency in the use of resources and capital to be a key criterion in the selection of strategy, and
(c) options for future development are not foreclosed.

Technical improvements are increasingly directed towards minimizing adverse environmental effects. However, for the same level of technology, sustainability may have different connotations. Attention is mainly given to achieve sustainability commensurate with the general development of a country Three studies have to be carried out for any developmental project, namely technical feasibility, environmental acceptability and economic viability. There should be close interaction amongst these studies. The environmental acceptability for sustainable development is taken up to ensure that the project impacts are within the supporting and assimilating capacity of environment. For this purpose, an environmental reconnaissance is carried out. If environmental reconnaissance shows that violation of environmental norms can not be avoided, a search for environmentally acceptable alternative is to be made and if such a search proves futile then the project will have to be abandoned. In case such norms are not violated or if an alternate is found feasible, project feasibility and environmental studies are taken up which interalia, include environmental management and monitoring programmes. These activities have to be reviewed, checked and corrected for achieving sustainable development

As pointed out in "Our Common Future" the report of the Brundtland World Commission on the Environment and Development (known after its Chairperson) good development should simultaneously protect and enhance the environment. Attention paid to environmental concerns should generally strengthen development programme and projects and should ensure that the expected benefits continue to flow for the betterment of the society. Sustainable development can only be achieved through environmentally sound management. What we require is guidance on operational methodologies and cost effective analytical tools to integrate environmental concepts within development policies, plans, programmes and projects. For each stage of project cycle there would be a matching environmental component. This is because environmental inputs must commence with the very reconnaissance of any project, Environmental Reconnaissance with Project Reconnaissance; Environmental Studies with Feasibility Study; Environmental Management Plan with final design of the Project and Monitoring and Evaluation of Environmental Impact during Constitution and Post construction Phase (Annex 4). The complexities associated with the prediction of the environmental impact could cover many subject areas. It is therefore generally desirable to use a multi-disciplinary team of specialists to conduct the required study and plans.

An approach for sustainable development and management can be achieved only through a systematic attempt through step as given below:

Preliminary issue
Identification

Baseline Study
Impact Prediction
Control Measures
Comparison of Alternatives
Documentation
Environmental Decision Making
Monitoring

- Improvement in social and economic conditions are needed. Development must continue to be promoted in both industrialist and less developed countries but we must find a way of creating a balance between the utilization of natural resources and economic growth. A desirable goal it would seem, would be to generate economic development which does not exhaust renewable and non-renewable resources.

Our aim should be to promote social and economic development through the proper kind of science and technology education. In environmental terms this means an education that leads to a rational utilization of the earth's resources. Since this is linked with the concept of sustainable development we can state major objectives of the environment theme as: "to demonstrate how a concern for environmental improvement can be articulated through a science and technology education which promotes sustainable development. The word sustainable is important, because science and technology have unfortunately, often used to foster development which leads to the exhaustion of natural resources, the deterioration of the environment and extinction of species. Public awareness of these issues was raised world-wide by the United Nations Conference on Human Environment held in Stockholm in 1972. An important outcome of the conference was creation of an new agency called the United Nations Environment Programme (UNEP). In response to, or in support of its declaration some Governments created or gave increased support to environmental protection agencies to reverse the trends that were leading to ecological disaster.

In the process a discipline called environmental education has evolved. Its main characteristics are : (a) a problem-solving approach, (b) an interdisciplinary educational approach, (c) the integration of education into the community, and (d) a life-long, forward looking education We have to find the best formulate for environmental education and sustainable development at every level and encourage people to think horizontally as well as vertically, a matter of whole society. It is necessary to orient in time and space. The classical place of education: everywhere; the classical time . always; the classical medium: everybody

Education for Environmentally Sustainable Development

Both environmental education and S & T education is being imparted at various levels, mostly giving conflicting ideas to young brains. The environmentalists show great concern about the environment, conservation of resources and protection of environment and oppose construction of dams, roads, implementation of large projects etc. while the scientists and technologists plan and execute projects for development to take care of increasing human needs. Thus there is a gap in the system. We need development with conservation which means that growth priorities do not sacrifice the needs of tomorrow for immediate compulsions. It requires closer associations of scientists and technologists with the environmentalists in the planning process. A need has been realized to retain a balance a continuity in the environment. The key word here is AWARENESS of the situation, the problems,

the solutions and mode.

For this education could be instrumental in filling the gap between the concern for environment and development. Our education system should be such that promotes environmentally sustainable development.

Thus a new concept of Education of Environmentally Sustainable Development (EESD) could be introduced in the education system which paves the way for the protection of the environment keeping in view the development needs of the society through science and technology. This would mean educating people for awareness, decision making and at a later stage implementing.

Environment Education concepts is already prevalent at various levels. EESD could either be merged with Environment Education or integrated with all other subjects.

Thus the requirement of EESD would be to integrate it into the whole system of formal education at various levels.

Primary level

Students could be made aware of the environment. At the same time importance and need for development through science could be taught. The curriculum planners and teachers responsible, can integrate the two without implanting any conflicting ideas between environment and development in the subtle minds of the young children.

Secondary level

Students could be introduced, while teaching science, the adverse impacts of technological developments on the environment. However, the stress will have to be laid on the developmental activities such that the environmental degradation is kept to minimum and if possible developmental activity should result in improved environmental conditions

Higher level

The target group should be introduced to the actual educational means (or tools) by which they can actually formulate plan and designs of the environmentally sustainable development projects

The ultimate goal of the EESD should be to mould the people into intelligentsia aware of and concerned about, the environment and its associated problems, and having the knowledge, skills, attitudes, motivations and commencement of working individually and collectively towards development solutions of current problems and the prevention of new ones. These global issues are not only for discussion but local actions could be taken.

The *objective* of EESD could be

(i) *Awareness* . to help individuals and social groups acquire an awareness and sensitivity of the ESD.

(ii) *Knowledge* . to help individual and social groups acquire basic understanding of the ESD and humanity's critically responsible presence and role in it.

(iii) *Attitude* : to help individual and social groups acquire social values, strong feelings and concern for the ESD and the motivation for actively participating in its protection and improvement.

(iv) *Skills* : to help individuals and social groups acquire the skills for solving ESD problems.

(v) *Evaluation ability* . to help individuals and social groups evaluate ESD measures and education programmes in terms of ecological political, economic, social aesthetic and educational factors.

(vi) *Participation* · to help individuals and

social groups develop a sense of responsibility and urgency regarding ESD to ensure appropriate action to solve these problems.

Suggestions

To bring about EESD effectively in our formal educational system the following can be done :

(1) Environmental topics merged with science syllabi could lay emphasis on conservation with development

(2) Students could be made to realize :
alternatives for non-renewable resources
interdependence of all life forms with each other and environment emphasis of intermediate technology
Need for development for both long and short term effects.

Conclusion

There is need for systematic campaign and education for environmentally sustainable development to educate governments, political parties, students from Pre-school age onwards and others, regarding the importance and relevance of conservation and the factors involved. At the same time in our anxiety to conserve other forms of life, let us not contribute to the denigration of human beings. People can be taught to live in peace with nature and themselves only if they are assumed of food and water, shelter and work. Let not the burden and cost of conservation fall on the poorest.

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Formulation and Naming of Coordination Compounds

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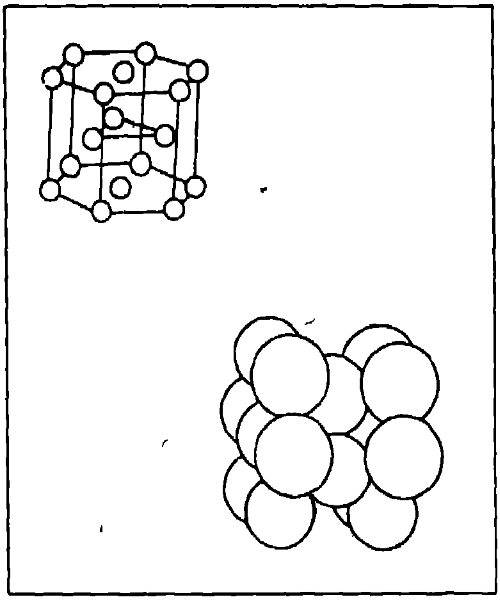

Several thousands of coordination compounds (complex compounds) are known and many new ones are being discovered each year. Therefore, it becomes essential to provide systematic rules for *formulation* and *nomenclature* of such compounds. A systematic method of naming such compounds (nomenclature) should provide us basic information about their structure. For example: Which is the metal present in the complex? Does the metal atom occur in the cation or in the anion? What is the oxidation state of the metal? What are ligands?

Naming and formulation of coordination compounds is done according to a systematic set of rules recommended by the International Union of Pure and Applied Chemistry (IUPAC). Rules provided for formulation and naming of coordination compounds in this article are the one approved by IUPAC in 1990.

Naming here implies the writing of the coordination compounds in words while *formulation* implies their representation in a symbolic form or in the form of a formula. Rules for formulation differ from those of nomenclature (naming). Therefore, before learning about the rules for naming of coordination compounds, let us see how their formulas has to be written.

We know that coordination compounds are basically inorganic compounds and like other salts, most of them consists of two constituents—cation and anion. A few coordination compounds are also found in molecular form.

How to Write the Formula

While *writing the formula* of coordination compounds following rules are followed:

Most of the coordination compounds are obtained as salt. Therefore, similar to a salt, while writing the formula of a coordination compound, cation is written first and then anion. For example in $K_2[PtCl_6]$ cation K^+ is written first followed by anion $(PtCl_6)$

In a coordination compound, sometimes only cation is complex, sometimes only anion is complex or sometimes both are complex. In a complex

ion, the metal atom/ion will be enlisted first followed by ligands. For example, in the complex ion $[(CoCl(NH_3)_5]^{2-}$ metal atom Co is written first followed by ligands, –Cl and $-NH_3$ Complex part is usually enclosed by brackets with the charges on them shown outside the brackets. Examples:

$(CrC1_6)^{3-}$

(It is however, not unusual for the brackets to be omitted especially for common complexes).

When a ligand contains more than one type of atom, it is enclosed by parentheses. For example,

$[Cu(NH_3)_4]^{2+}$

When a complex contains more than one kind of ligands, anionic ligands are written before neutral ones. If there are also cationic ligands, they will be written in the end (cationic ligands are rare). Within each class, ligands are written in alphabetical order.

Examples are :

$[CrCl_2(NH_3)_4]^-$ (anionic ligands –Cl are placed before the neutral ligands $-NH_3$)

$[CoBrCl(H_2O)_4]^+$ (anionic ligands –Br and –Cl are placed before neutral ligand, $-H_2O$ in alphabetical order).

How to Name Ligands in Coordination Compounds

Before naming coordination compounds, it would be relevant to name ligands.

1. *Anionic Ligands*[1]

a) While serving as ligands, if name of an anion ends in–ide the ending is changed –'O' i.e. –ide is replaced by –o. Examples are provided in Table 1.

TABLE 1

Anion	*Anion name*	*Ligands*	*Ligands name*
F^-	Flouride	-F	fluoro
Br^-	Bromide	-Br	bromo
OH^-	Hydroxide	-OH	hydroxo
CN^-	Cyanide	-CN	cyano
O^-_2	Oxide	-O	oxo

b) If a ligand is an anion and its name ends in 'ate' then the name 'ate' is changed to 'ato'

Anion	*Anion name*	*Ligand*	*Ligand name*
SO_4^{2-}	Sulphate	$-OSO_3$	sulphato
$S_2O_3^{2}$	Thiosulphate	$-SSO_3$	thiosulphato
$C_2O_4^{2-}$	Oxalate	$-O(CO_2)_2O-$	oxalato

c) Other anionic ligands

Anion	*Anion name*	*Ligand*	*Ligand name*
SCN^-	thiocyanate	-SCN	thiocyanato
SCN^-	isothiocyanate	-NCS	isothiocyanato
NO^-_2	nitrite	$-NO_2$	nitro
NO^-_2	nitrite	-ONO	nitrito

2. *Neutral (Molecular) and Cationic Ligands*

In most cases, the name of molecules and cations (rare) and not changed when these species serve as ligands. (There are some exceptions to this rule, however) The most important of these are :

Molecule	*Molecular name*	*Ligand*	*Ligand name*
H_2O	Water	$-OH_2$	aqua (formerly aquo)
NH_3	ammonia	$-NH_3$	ammine[2]
CO	carbon monoxide	–CO	carbonyl
NO	nitrogen monoxide	–NO	nitrosyl

[1] In the formula of each ligand, the dash in front indicates the atom that is bonded to the central atom in the complex.

[2] Compare the spelling for ammonia complexes with spelling of amines for RNH_2.

Naming of Coordination Compounds

After having learnt the rules for naming ligands, it becomes easy to name coordination compounds. Following method is followed in writing the name of a coordination (complex) compound :

In coordination compounds (which are mostly salts), the name of the cation is giving before the name of the anion.

Thus, in the coordination compound $[CoCl(NH_3)_5]Cl_2$ we first name $[CoCl(NH_3)_5]^+$ and then Cl within a complex ion or a molecule, ligands are named first followed by the central metal atom (Note · This is the reverse of the order in a formula). For example: $[Cr(H_2O)]_6^{3+}$ is named as hexaaquachromium (III) ion. Some metals exhibit variable oxidation state. The oxidation state of such metals is designated by Roman numerals in parentheses immediately after the name of the complex ion or molecule. Here one should always remember that no space is left is between.

For example in $[Co(H_2O)_4]^{2+}$ which is named as tetraaquacobalt(II) ion, Roman numeral II is parentheses represent oxidation state of cobalt. The number of each type of ligand is indicated by using the Greek prefixes: di, tri, tetra, penta, hexa, etc. Example:

$[FeCl_2(H_2O)_4]^+$ is the tetraaquadichloroiron (III) ion.

If the name of the complex contains *more than one kind of ligands,* the ligands are listed in alphabetical order of their names. (In determining the order, one should ignore prefixes and also distinction between anionic and neutral ligands.)

For example, $[CuBr(H_2O)_3]^+$ is named as triaquabromocopper(II) ion. Here 'aqua' is listed before 'bromo'. However, in writing the formula anionic ligand is written first and then neutral ligands.

Similarly $[Co(CN)(NH_3)_4(H_2O)]Cl_2$ will be named as tetraammineaquacyanocobalt(III) chloride.Here one should keep some space between names of cation and anion of the coordination compound. (Note: When a prefix denotes the number of substituents on a single ligand as in dimethylamine, $NH(CH_3)_2$ it is used to alphabetize ligands). Complexes that are anion, are named with the suffix *-ate* added to the stem of the English name of the central metal atom. Exception is only when the symbol for the central atom is derived from the Latin name of the element, the suffix *-ate* is added to the stem of the name, Examples .

$[(CrCl_6)]^{3-}$ is the hexachlorochromate(III) ion

$[(CuBr_4)]^{2-}$ is the tetrabromocuprate(II) ion

The following table provides Latin name and anion names

TABLE 2

English name	*Latin name*	*Anion name*
Copper	Cuprum	Cuprate
Gold	Aurum	Aurate
Iron	Ferrum	Ferrate
Lead	Plumbum	Plumbate
Silver	Argentum	Argentate
Tin	Stannum	Stannate

If the name of the ligands itself contains a Greek prefix, such as mono or di the name of the ligands is enclosed in parentheses and alternate prefixes bis, tris, tetrakis, hexakis- are used. For example, the name for $[Co(en)_3]Cl_3$ is

tris (ethylenediamine) cobalt (III) chloride.

There are ligands which can attach themselves to a central metal atom in different ways as stated earlier. For example, No_2^- and CN^-.

When 'nitrogen part of the ligand is attached, we indicate sometimes by writing -N - before metal. For example $[PtBrCl(NO_2)(NH_3)]^-$ is named as amminebromochloronitrito-N-platinate(II)

Examples to illustrate formulation and naming of coordination Compounds/ Complex ions;

$[CoCl(NH_3)_5]Cl_2$ pentaamminechlorocobalt (III) Chloride
$[CoCl(NO_2)(NH_3)_4]Cl$ tetramminechloronitrito-N-Cobalt(III) Chloride
$[PtCl(NH_2CH_3)(NH_3)_2]Cl$ diamminechloro(methylamine)platinum(II) Chloride
$K_2[PaCl_4]$ pottasium tetrachloropalladate(II)
$[Fe(CNCH_3)_6]Br_2$ hexakis (methylisocyanide)iron(II) bromide
$[Cr(OH)_2(H_2O)_4]^+$ tetraaquadihydroxochromium(III) ion
$[FeCl_2(CN)_2(NH_3)_2]^-$ diamminedichlorocyanoferrate(III) ion
$[FeBr_2(CO)_4]^+$ dibromotetracarbonyliron(III) ion
$K_4[Ni(CN)_2(OX)_2]$ potassium dicyanobis(oxalato)nickelate (II)
$[Fe(CNCH_3)_6]Br_2$ hexakis (methylisocyanide)iron(II) bromide
$[Ru(HSO_3)_2(NH_3)_4]$ tetraamminebis(hydrogen sulphito) ruthenium (II)
$[Cr(en)_3][Co(CN)_6]$tris(ethylene diamine)chromium(III) hexacyano cobaltate(III)
$[Co(ONO)(NH_3)_5]Cl_2$ pentaamminenitritocobalt(III) chloride
$[CoCl_4(en)]^-$ tetrachloro (ethylenediamine)cobaltate(III) ion

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The Golden Key to Mass Literacy

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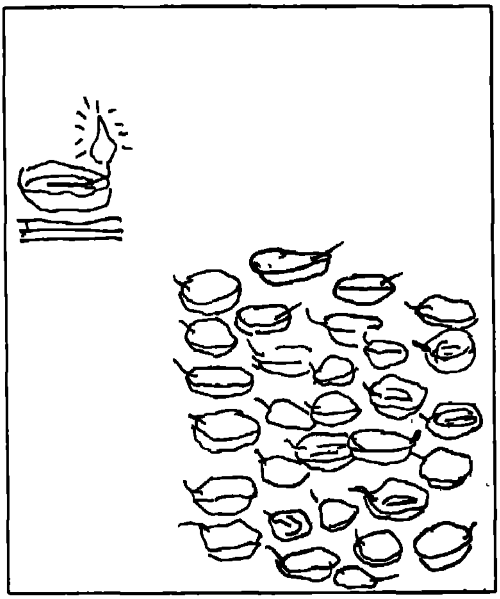

Widespread literacy, which we take for granted in modern societies, did not exist (and was impossible) just a few centuries back. In those days, less than one per cent of the population could read and write well The main reason was that books could not be mass-produced cheaply. Knowledge of literature, religious texts etc., was confined to a very small group of people, while the mass of the population remained abysmally ignorant and uneducated.

The invention that shattered this condition and produced a profound change in human affairs was the process of PRINTING. It marked one of the cardinal turning points in history. With the aid of printing, knowledge could be disseminated rapidly and permanently recorded. Languages, which had the tendency to split into regional dialects, could be standardised through printing and spread to encompass large nations. The uniformity of the written language in the European nations of today was brought about mainly by printing. Mass education became possible for the first time in human history. With the spread of education Science progressed swiftly. Widespread education and awareness weakened the power of ruling cliques and led to the spread of Democracy. All the modern scientific, technological and political advancements that we enjoy today would have been impossible but for the development of printing.

Printing also played a great part in reviving and preserving ancient knowledge, though it was done for purely commercial reasons. In order to keep their presses occupied, printers scoured libraries and monasteries, then the repositories of ancient books and manuscripts, and brought out several classic works of literature, which the mass of the people would otherwise never have come across.

It is a puzzling feature of History that certain developments 'take off' only during certain periods, even though the essential ingredients for them were available much earlier. Printing is one such development. The Chinese had developed printing nearly six hundred years earlier than the Europeans! But it did not produce in China the revo-

lutionary changes that Europe experienced. Were cultural and social reasons responsible for this? What would have been the course of History if the Modern Era had dawned in China instead of in Europe, and that too several centuries earlier? No one knows!

But what we do know is that modern printing began in Europe by the middle of the fifteenth century A.D. Johannes Gutenberg of Germany is generally credited with being its father. But he too only skillfully combined several elements which already existed. The most important of these were the movable type, suitable inks and paper. In the movable type, individual letters of the alphabet, made of an alloy of tin and lead, could be assembled to form a page and then could be disassembled for reuse. Inks were generally a combination of carbon black and linseed oil. Paper making, again first developed by the Chinese nineteen centuries back, had reached Europe by the twelfth century A.D. Gutenberg himself developed the first hand-operated screw press. After some years of trial, he began commercial printing around 1450. His most famous handiwork was the printing of the Bible (which came to be called the Gutenberg Bible).

Through craftsmen, mainly trained by Gutenberg, printing slowly spread to other European countries. Developments then came in rapid succession. Colour printing, illustrations, stereotyping, lithography etc., came into use in the next two centuries. But it was the invention of the rotary press by Richard Hoe of New York in 1846 that made the production of mass circulation newspapers and magazines possible. (See Fig 1). Columns of type were fixed around the circumference of a large, rotating drum. The paper to be printed was fed continuously between this drum and another drum in contact with it. The drum containing the type was continuously inked by an inking system. The effect of mass printing of books and newspapers can hardly be exaggerated Systematic education of the whole population became possible for the first time in history. The latest news and up-to-date knowledge were spread rapidly to the masses. The press became a powerful watchdog of public interest. Exploitation and hoodwinking of the masses by small ruling groups became more difficult. It is a telling fact that all authoritarian governments in the world take particular care to control the press. There could be no greater proof of the power of the press!

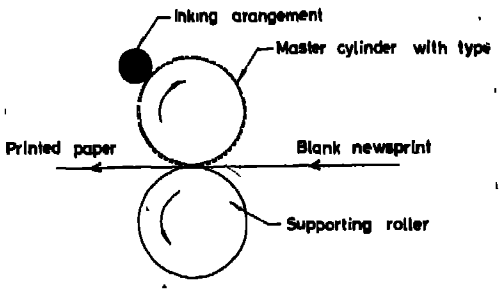

FIG 1. Principle of the Rotary Press

In recent decades there have been such profound technical advances in the process of printing that it had changed more in the past fifty years than in the previous five hundred years. This has been mainly due to the intervention of electronics. Full pages, including illustrations, can now be composed on the computer video screen. It is then transferred by a laser scanner to a photographic paper and finally to a printing plate. Spelling checks, spacing of lines etc. are automatically taken care of by the Computer. And all this is done at an incredible speed.

The electronic revolution, however, has also had an adverse effect on books and newspapers. Television present news and reports in a much more attractive form than newspapers and books and demands less effort from the viewer. There is a widespread apprehension that this will affect the habit of reading books.

However, this apprehension is unfounded. Actually, more books and newspapers are being printed today than ever before in history. Printed matter has its own fascination. A good reader is in constant interaction with a book, digesting the meaning, ruminating over it, questioning it etc. Serious study of any subject is possible only through the medium of books. Hence printing can never be totally supplanted by any other means

As we survey all the benefits that printing has bestowed on mankind since its historically recent invention, we can understand the reverence that books have traditionally commanded in our country as the manifestation of Goddess Saraswathi, the fountainhead of education and wisdom. It has indeed been the magic wand that has showered the benefits of education and culture on the entire population of modern societies.

Tips in Representing the Open Chain Structure of Monosaccharides

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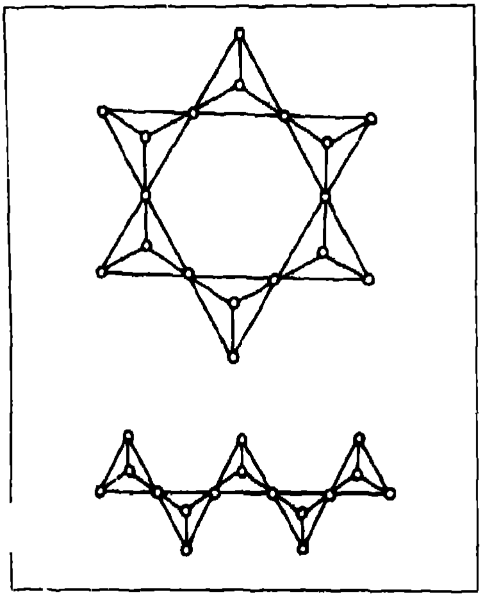


The task of memorizing and reproducing the structures of monosaccharides has often posed problems among students. This is because each sugar structure not only differs with respect to number of hydroxyl groups but configuration as well.

Based on two decades of teaching experience in carbohydrate chemistry by the author and the difficulties experienced by the students, a simplified notation method has been devised for drawing the open chain structure of monosaccharides. Tips for the same have been presented in this communication.

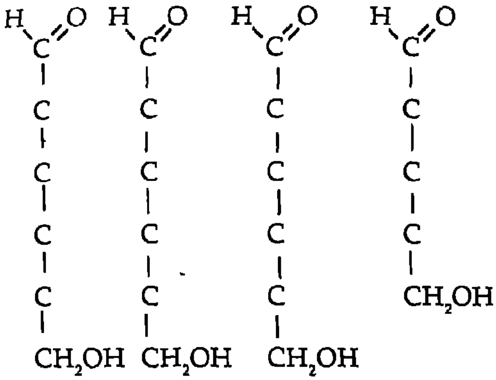
Aldosugars

Firstly, tips for representing the open chain structure of commonly occurring sugars such as glucose, mannose, galactose (aldohexoses) and ribose (aldopentose) are explained herein.

1. The aldohexoses, glucose, mannose and galactose have six carbon atoms whereas ribose, has five. Hence, one can draw the skeletal structure of the aldosugars as follows :

C	C	C	
|	|	|	
C	C	C	C
|	|	|	|
C	C	C	C
|	|	|	|
C	C	C	C
|	|	|	|
C	C	C	C
|	|	|	|
C	C	C	C
Glucose	Mannose	Galactose	Ribose

2. The presence of first carbon atom as an aldehydic group and the terminal carbon atom as a primary alcoholic group is characteristic of an aldosugar. Thus the sugar structures can be represented as



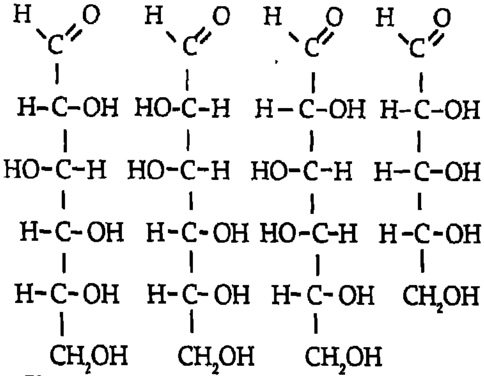
Glucose Mannose Galactose Ribose

The partial structures at this point do not differ. However, as indicated earlier, the most crucial step in depicting the structure of sugars is the orientation (configuration) of hydroxyl group at each carbon atom. An alteration in the position of the -OH group from left to right or vice versa at a particular carbon atom of a given monosaccharide would change its configuration and the saccharide structure.

In view of the different orientations at the asymmetric carbon atom of sugars and the difficulty experienced in drawing the structures, a simplified right-left notation has been devised. The right-left notation relates to the position of the -OH groups, apparently the other side (valency) of the carbon is substituted by hydrogen. Thus one could write the structure of the said sugars with the following tips :

Glucose - right, left, right, right, (RLRR)
Mannose - left, left, right, right (LLRR)
Galactose - right, left, left, right (RLLR)
Ribose - right, right, right (RRR)

The structures based on the above notation method are as follows :

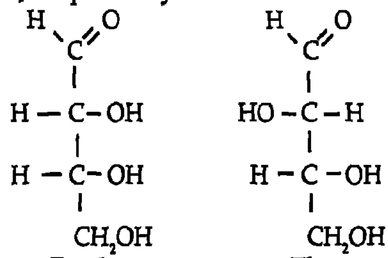


Glucose Mannose Galactose Ribose

Similarly, the isomers of ribose, such as arabinose and xylose, the aldopentoses, can be represented with the following tips:

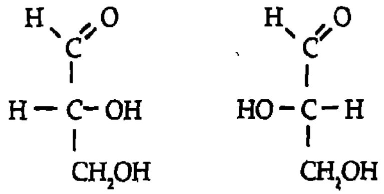
Arabinose - left, right, right (LRR)
Xylose - right, left, right (RLR)

Further, the clues for representing the structures of aldotetroses viz. erythrose and threose are right, right (RR) and left, right (LR) respectively.



Erythrose Threose

In glyceraldehyde, the aldotriose, there is only one asymmetric carbon atom, hence a shift of the - OH group either to left or right alters its configuration.

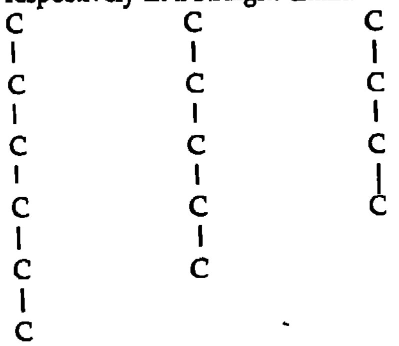


D-Glyceraldehyde L-Glyceraldehyde

Ketosugars

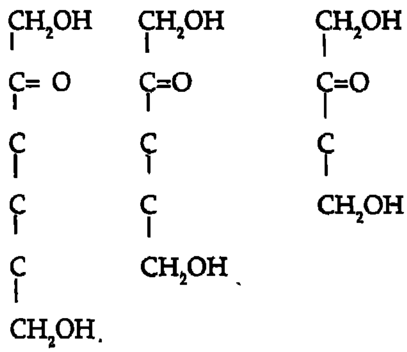
On similar lines, the open chain structural formulae of ketosugars such as fructose (ketohexose), ribulose (ketopentose) and erythrulose (ketitetrose) can be represented with the following hints.

1. Draw six, five and four carbon atoms respectively in a straight chain.



Fructose Ribulose Erythrulose

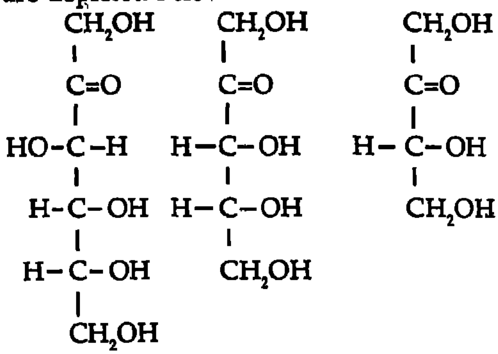
2. Most of the ketosugars posses ketonic group at the second position. In addition, the presence of the first and terminal carbon atoms as primary alcoholic groups is characteristic of these sugars. The partial ketosugar structures are as follows :



Fructose Ribulose Erythrulose

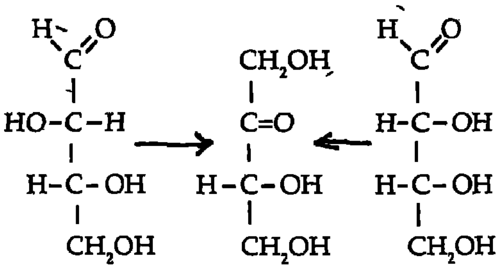
3. The arrangement of hydroxyl groups at the asymmetric carbon atoms of the sugars chosen are :
   Fructose - left, right, right
   Ribulose - right, right
   Erythrulose - right or left

Structures based on the above notations are depicted below :



Fructose Ribulose Erythrulose

Among ketotetroses, only erythrulose is possible.



Threose Erythrulose Erythrose

The orientation of the hydroxyl group at the asymmetric centre of erythrulose determines the D or L configuration and the one represented above is of D-configuration. Dihydroxyacetone, the ketotriose, is optically inactive as it lacks an asymmetric carbon atom.

Conclusions

Based on teaching experience in carbohydrate chemistry, a simplified right-left notation method has been devised for representing the straight (open) chain structure of monosaccharides. The method developed was evaluated by several batches of undergraduate and post-graduate students and was found to be easier to memorize and reproduce. It also evoked a good response among the students.

Acknowledgment

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The Pupil, Geology, and the Science Curriculum

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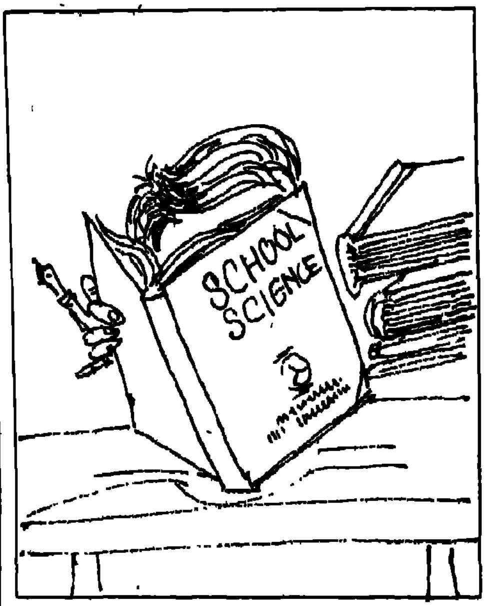

Relevant principles of psychology in teaching and learning must be followed when pupils engage in ongoing units of study pertaining to geology in the science curriculum. Thus, experiences for pupils should follow these standards or criteria:

1. learning activities should be interesting and meaningful.
2. pupils must have needed background information and posses adequate readiness for new units of study.
3. learners should perceive purpose in developing learning in ongoing units of study.
4. each pupil should be guided to achieve optimal development in understandings, skills, and attitudinal objectives.
5. learner progress must be continuously evaluated to determine progress in achieving desired objectives.

Objectives for Pupils to Achieve

Objectives for pupils to achieve must be selected carefully. Thus, relevant objectives may be emphasized in each unit of study. If pupils, for example, are studying a geology unit on Changes on the Earth's Surface, objectives such as the following may be stressed:

1. understand the differences between constructional and destructional forces as they change the surface of the earth.
2. attach meaning to the concept magma as it relates to volcanoes and volcanic eruptions.
3. understand the concept of faulting in the earth's surface and its results.
4. define and describe causes of earthquakes and the use of the seismograph.
5. understand the concept of folding, its causes and effects.
6. attach meaning to these terms - igneous, sedimentary, and metamorphic rocks.
7. understand destructional forces on the earth's surface such as the impact of wind, plants, water, glaciers, and sunlight.
8. develop listening, speaking, reading and writing vocabularies
9. observe and record science phenomena

accurately.

10. perform experiments in science carefully and responsibly .
11. think critically, creatively, and engage in problem-solving activities.
12. appreciate the methods of science in gathering and appraising information.
13. have a desire to learn more about the changing surface of the earth.

Learning Activities to Achieve Objectives

After relevant objectives have been selected for pupils to attain the teacher needs to choose related learning activities which aid in achieving these desired ends. Interesting, meaningful, and purposeful learning experiences for pupils in the unit 'Changes on the Earth's Surface' may well include the following :

1. Pupils collecting rocks and brining them to the class setting. These rocks should be classified and labeled as being igneous, sedimentary, and metamorphic. Learners may gather data to find out how these rocks were formed.
2. Current events/items pertaining to earthquakes, volcanoes, and other changes on the earth's surface can be brought to the class setting by pupils individually and discussed with others.
3. Pupils may collect pictures of folding, faulting, volcanic action, diverse kinds of erosion, and earthquakes in developing a committee or class scrapbooks. Pupils should develop needed understanding as to the causes of these phenomena.
4. Pupils may view and discuss selected filmstrips and films pertaining to earthquakes, folding, faulting, volcanic eruptions, and the formation of igneous, sedimentary, and metamorphic rock.
5. Excursions can be taken into the community to observe the use of natural rocks in the construction of buildings and monuments.
6. Snapshots, pictures, and slides may be viewed and discussed pertaining to the use of diverse kinds of rocks to meet functioning and esthetic needs of human beings.
7. Pupils in a committee with teacher guidance may gather data on the changing surface of ocean floors. Findings for the report may be presented to peers in the class setting. This committee can develop a mural related to the content of the report.
8. Pupils may draw individual pictures or develop a frieze on folding, faulting, earthquakes, or a volcanic eruption. Adequate background learnings need to be in evidence before pursuing this activity.
9. Learners can develop a report using a variety of reference sources on the formation of caves. A related diorama on caves may be made by each committee of pupils to shows to classmates as content from the report is presented orally.
10. Pupils with teacher leadership may take an excursion on the school grounds or into a rural area to observe sheet and gulley erosion. Observations by pupils should also be made of steps being taken to prevent diverse kinds of erosion.
11. Other related learning experiences could pertain to pupils reading selected content from science textbooks, examining different kinds of soil and rock particles using a magnifying glass, and working at different learning centres on tasks pertaining to the changing surface of the earth.

Appraising Pupil Achievement

The teacher needs to appraise pupil progress continuously to determine achievement. There are diverse methods which may be utilized to asses pupil achievement.

1. Using teacher observation The teacher may observe many facets of a pupil's achievement. Thus, progress of learners, for example, may be noticed in areas such as performing science experiments well, participating fully in discussions, and writing major conclusions and generalizations.
2. Using anecdotal records. The teacher may record every few weeks statements of representative behaviour for each pupil in an ongoing unit of study. Ultimately, the teacher can notice patterns of behaviour for each learner as items from the behaviour journal are analysed and summarized.
3. Using teacher-made test items. The teacher may write true/false, multiple choice, completion, matching, and essay items to evaluate pupil progress in each unit of study. Teacher-written test items should reflect clarity in writing and be on the understanding level of pupils: These test items should be valid in terms of covering what pupils have had access to in learning within a unit or a part of a unit of study. Learners must have an adequately developed writing vocabulary to respond effectively to essay test items.
4. Using self-evaluation. Pupils with teacher guidance should have ample opportunities to appraise their own progress. Self-evaluation on the part of pupils must be related to standards or objectives. Thus, pupils may notice how well they are achieving in ongoing units of study in the science curriculum.
5. Using other evaluation procedures. Additional appraisal techniques which may be utilized to evaluate learner achievement include the use of rating scales and the evaluation of pupils' completed written and art products.

In Summary

The teacher needs to select relevant objectives for pupils to attain, appropriate learning experiences to achieve these objectives, and effective appraisal techniques to determine pupil progress in ongoing units of study in the science curriculum.

How to Organise A Science Club

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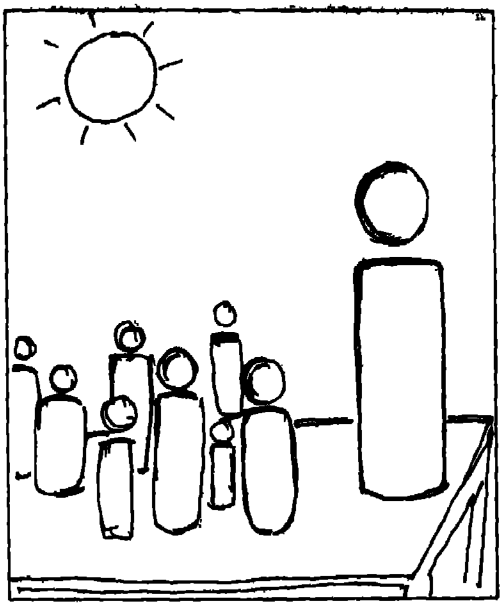

Science Club is a simple world for a complex notion which connotes activities of varying complexities. The club extends opportunities for activities in science beyond those that can be provided in the regular classroom programme and thus serve as the take off point for a wide variety of youth activities. The club also provide opportunities for research and conducting experiments beyond those found in regular science curriculums' provides vocational guidance, give training in leadership and encourage a spirit of cooperation among members.

Science Clubs are basically associations of active young scientists guided by very enthusiastic persons. It is a platform made available by young scientists to the young scientists to share their own experience.

Science Clubs are one of the oldest methods to popularise science. In the early 18th and 19th Centuries, a large number of literary and philosophical clubs were formed in England and America having eminent scientists as members, who used to disclose their discoveries and inventions first in science clubs. The first club to have men of science as members was the Spalding Gentleman's Society Club of 1710-1750, founded by Maurice Johnson and had members like Isaac Newton and Anders Celsius. During the same period there was a French Club, Societe 'D' Arcucil which used to have its meetings at the residence of Pierre Simon Laplace. Althaneacum was another club with Michael Faraday as Secretary for some time. The Club of Royal Philosophers, later the Royal Society Club, had members like Benjamin Franklin. Another famous and influential society was the Lunar Society of Birmingham, so called since it met every month on the Monday nearest to the full moon. Erasmus Darwin, a botanist and father of Charles Darwin, James Watt and Joseph Priestly were some of its members.

Aims and Objectives

The basic aims and objective of a Science Clubs are —

a) to develop among students the general

awareness of science and role of science in social affairs.

b) to train students in the use and practice of science methods through investigative questions, problems and projects.

c) to develop among students certain scientific skills : manipulative, communication and concrete.

d) to develop among students scientific interests in various branches of science.

But, since, Science Club is an evolving activity, other aims and objectives may be added later on. However, the basic goal of the Science Club remains the same i.e. to take up various activities and creative experiments to experience that science is enjoyable, science is fun and science is for all.

Science Clubs have the potentiality to become a nucleus of science teaching and link classroom and laboratory activities with the community. The formal and informal activities of the science club can play a very important role in the field of science education and communication. Certain studies in the United States and the Philippines have shown that 95 per cent of Science Club members pursue science as their career and 50 per cent of them have been awarded Ph.D. Degrees. It proves that Science Clubs do help in creating an interest amongst students in Science. This in turn makes the task of the teacher a little easier in explaining various concepts in the classroom. Science Clubs are the real hatcheries of future scientists and technologists.

Who should Form the Science Clubs?

An active and interested membership in the most important ingredient in a successful club programme. Generally enthusiastic science teachers should act as sponsor of science clubs and the interested and active students from all the classes should be the members The membership should not be restricted to the gifted only. Membership rules should be such that they attract those seriously interested in science and discourage the socializers interested only in belonging to a club Regularity of attendance, some creative performance or activity in science, usually indentify the serious members The sponsor should volunteer for the honorary services for the science club.

Establishing a Science Club

The first step in the establishment of a science club is to design and establish the constitution. The constitution should describe about the official body of the science club, the procedure of the election of the officers, duties of each officer, members' qualifications, the amount for membership to be collected from student members, the frequency of elections and the sources of funds.

A steering committee comprising of Secretary, President, Vice President and Treasurer should be elected in the meeting of the teachers and then there should be two active students from each class on the Council of the Club. The elected officers, the representatives from each class and the faculty advisers should form the council of the Science Club. The council is the official governmental body of science club. The club should be given a suitable name and the members for the club may be registered.

The council of the science club may then discuss elaborately the indoor and outdoor activities of the club, the important events to be celebrated by the club and so on.

The sub-committees on various subjects for the activities may then be formed and the responsibilities may be allotted to them. Some of the Sub-Committees that most of the clubs need are publicity, membership requirement, fund raising, community and

inter-school relations, library etc.

Requirements of the Science Club

In addition to the enthusiastic council and active young members there are four basic requirements which have to be fulfilled.

1 Place for Science Club
2. Hardware support
3 Software support
4 Funds

Place for Science Club

There should be sufficient place for functioning of the science club. Normally this should not be a problem in the schools.

Hardware

The Science Club should have certain tools, measuring instruments and materials for the projects or the experiments that are to be conducted by the members. Basic workshop tools such as soldering iron, small bench vices, hacksaws, chisels, hammers, files, hand drilling machines, cutters, pliers, screw drivers, spanners and small meters are required for the club Certain materials such as card boards, pieces of plywood, teak wood, acrylic pieces, pasting materials and few educational materials such as lenses, mirrors, magnets etc. are sufficient initially. Other hardware material may be added later on.

Software

Science Clubs have to plan various programmes and activities throughout the year. Certain programmes are to be conducted daily whereas some programmes may be conducted weekly, monthly or yearly. Regarding the activities that can be taken up by science clubs there is no limitation as such

Activities of the Science Club

There is no limit or definite guideline for the activities to be undertaken by the club throughout the year. A general idea of the nature of programmes and activities that can be arranged for and by the students members can be obtained from the following list.

1 Geological study
2. Weather observation
3. Aeromodelling and Model Rocketry
4. Model building
5. Pet Care
6. Mechanical Modelling
7. Sky Observation
8 Inter-class quizes/debates and other competitions
9. Popular Science lectures by professional and eminent scientists
10. Film shows
11. To take up exciting Science Projects
12. Electronics & Electrical Hobby Projects
13. Science Bulletin Board
14. Science Publication
15. Visit to Scientific Institutions
16. School Science Museum/Centre
17. Annual School Science Exhibition
18. Career guidance in Science
19. Photography
20. Telescope Making
21. Energy Conservation
22. Computer programming
23. Food and Nutrition

Apart from these activities investigative projects such as community health service, pollution study, drinking water sampling, science news cataloging can also be taken up. Every club should also spend time to knowing the history of science and the world of great scientists. The lives and experience of these great scientists will inspire the members.

Funds

The funding of an active and successful club will require creative sources of revenue, usually it is not a question of whether money is available but rather how to obtain it. Money will come from many ways in a successful club. The principals of the schools are the right people to approach first, The principals may also take up this matter with the Education Departments for providing them additional funds for science clubs. Donations from various social organisations may also be tried. For this purpose effective communication by the officials of the club is very important. Contribution from the members of the club may also help though very little.

Management of Science Clubs

Successful functioning of a Science Club solely depends on the sponsor teacher in most of the cases. However, lack of clearly defined goals, tight schedule for the members etc. tend to dissipate the initial enthusiasm by which a club is formed. Therefore, it is necessary to have a very motivated sponsor to run a science club and to maintain the enthusiasm by rotating the post among motivated teachers. The sponsor should also be able to develop specific interests among the students where they are lacking and then turn specific interests in to plausible projects. This is required because frequently it has been found that though science-oriented students join the club, their preference for a project or the activities of club is not decided at the time of joining and hence require guidance from experts or sponsor. It is also recommended that such science teachers, in charge of science clubs, be given certain concessions in terms of teaching period, flexible hours of work and other incentives, it possible.

It is observed that participation of students members in the management and formation of different student committees have greatly helped in the successful functioning of the club and the organisation of its activities. It is also observed that the role of the school principal or head of the institution is very important as he/she himself/herself would be the nucleus of the activity.

Monitoring, Evaluation and Conclusion of Yearlong Activities

Periodic monitoring of the work or progress of club activities would give a feedback which in turn will help in better coordination and planning of club activities in future. Therefore, there should be a proper mechanism to evaluate the progress of the club

A good presentation of the year long activities in the form of a school exhibition, slide presentation or a written report would be the appropriate valediction. Review of the achievements and future plans may be made open to school board members, donors, parents and other connected with school activities.

Students' Concept of Energy and Its Implications for Curriculum

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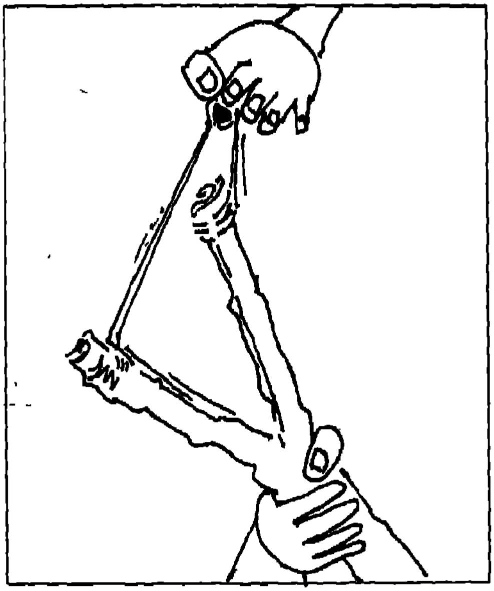

Many attempts (e.g. Goldring and Osborne 1994, Saxena 1990, Solomon 1983, Solomon 1992 and Watts 1983) have been made to explore children's conception of energy and these have also been reviewed (e.g Driver, Squires, Rushworth and Wood Robinson 1994). Using children's ideas various approaches have been suggested (e.g. Duit and Orfax 1983, Duit 1981, Duit and Haeussler, (year not mentioned) for teaching energy. Students' ideas have been explored using various techniques such as interview-about-instance approach (Gilbert, Watts and Osborne 1982), asking questions on line diagrams (Watts 1983), recording discussion and analysing students' response to tests through normal homework and end-of-year examination (Solomon 1983), asking students to predict in the tasks involving energy (Duit 1981) and other similar techniques. It has been shown (e.g. Novak 1964, Novak 1990) that concept map drawn by the students could be used to gauge students' understanding of a concept. This study was taken up with the following objectives :

1. To what extent the concept maps drawn by the students are stable with time ? And how could one use the concept maps drawn by the students as a tool to gauge their framework?
2. What is the students' concept of energy as reflected in the concept maps drawn by them?
3. Could the information so gathered be used for curriculum planning? If yes, what are its implications?

Sample

Students studying in one section of standard IX in a school of Bhopal city were selected for the purpose of study. The entire intact group in that section was subject of study. However, those who were absent on any one of the two occasions when students were asked to draw concept map, were dropped from analysis for obvious reasons. The group contained 24 students out of which 7 were boys and 17 were girls. However, during the analysis the sex was ignored. The age of the students ranged

from 13 years 3 months to 14 years 11 months with an average of 14 years 5 months. The school caters to the middle class of the society. They were explained to draw concept map as part of the curriculum and had experience of drawing at least 4-5 concept maps related to the units of force and acceleration, light, heat etc. Therefore, no separate instructions were given to draw the concept map.

These students had already studied the unit— 'work and energy' as part of their curriculum. This unit has the concepts of kinetic energy, potential energy, mechanical energy, work and power They had also studied the units on wave motion, heat and light.

Plan of Study

In phase I, the students were asked to draw concept map of energy as they understood it by showing its relationship with other concepts known to them. No specific instructions were given to them. After a gap of about four weeks, in phase II, students were again asked to draw the concept map of energy. However, this time they were asked to show on the concept map relationship regarding— (1) Conservation and destruction, (2) unit, (3) types, (4) uses, (5) transformation (into other forms), (6) the form (7) relationship, (8) methods of transfer, and (9) uses of energy However, these points were written on the blackboard but were not elaborated while asking to draw the concept maps.

The concept maps drawn by students were carefully analysed and common features were noted. A typical concept map drawn by the student is shown in Fig 1.

Analysis and Results

The point that was noted in the concept maps drawn was the number of relation-

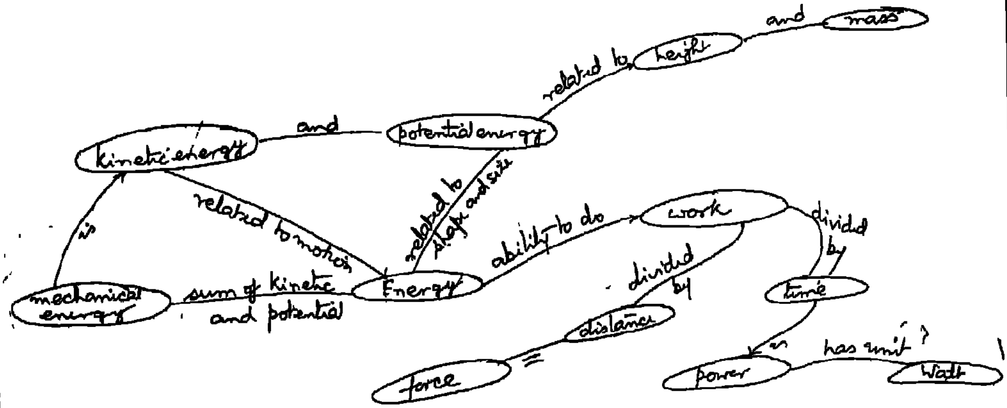

FIG.1 · A typical concept map drawn by a student (redrawn)

ship shown irrespective of its being right or wrong. The number of such relationships was found to be about 20 per cent more in phase II in comparison to phase I. This is though significant, but is not substantial. This was also expected because in the phase II the bases of drawing concept map was also told to the students. The concept map included two kinds of relations: (i) that are covered in the nine areas related to energy mentioned in phase II and (ii) that are scientific, yet not related to any characteristics of energy directly. For example, 'Kinetic energy is a kind of energy' is of the first kind, whereas the statement 'Force is directly proportional to acceleration' falls in the second category. The relationship of second category were ignored in the further analysis because they do not tell us much about concept of energy, though these may be significant for other reasons.

Secondly, the characteristics (of the second category) shown on the concept map were further looked into. To arrive at the students' concept of energy, the nine areas that were mentioned in phase II were further used as the basis of understanding. On this basis, the concept of energy reflected in the concept maps drawn in two phases were compared. It was found that the concept of energy in the two maps drawn was mor or less same in two phases. This could be seen from the following facts :

1. Energy was most commonly described as 'ability to do work'. Fifty-four per cent students stated this as the nature of energy in phase II and 50 per cent students mentioned this in phase I stage. This is also how the textbook (MPTC 1991) defines energy.
2. In both phases students described the energy mainly in terms of mechanical energy. Forty six per cent and forty two per cent respectively described it as sum of kinetic and potential energy.
3. About equal fraction (approximately one third) of students described kinetic energy qualitatively, as to motion. Little more, but almost equal to 35 per cent described it mathematically as ½ mv^2. Similarly, potential energy as mgh in 38 and 30 per cent cases, in two phases; and forgot potential energy due to other reasons.

Thus, it could be safely concluded that the basic concept map of the students was quite stable and was reflected truly in the concept maps drawn by them. However, to get more information about it, it is better to give the guiding points: This helps to reflect the ideas more exhaustively.

As stated earlier, there are more number of relationships shown on the concept map drawn in phase II. For the purpose of drawing implications to construct curriculum and teaching of 'energy', therefore, the important features of concept map drawn in phase II were used only. These were mainly related to 'sources', 'types of energy', 'conservation/destruction of energy' and 'uses of energy'. The following observations were made in this context :

(i) Sources of energy ·

Coal, petroleum and sun	- 17%
Light	- 8%
Heat, electricity and sound	- 4%

(ii) Kinetic energy was shown most frequently as types of energy (29%) followed by heat (25%), potential energy (17%), light (8%), electricity and sound (4%).

(iii) Eight per cent stated that energy is used for living and 4% stated for industry and agriculture.

(iv) Twelve per cent said that it can be trans-

ferred and eight per cent stated that it cannot be destroyed.

(v) Mathematically, the most common relationship shown was :
Mechanical energy = potential energy + Kinetic energy

The following misconceptions also appeared on the concept map :

(i) The most common misconception was that we need energy to apply force (25%). Another misconception that was equally frequent was that potential energy is due to height of the body. Many times it was also expressed as mgh to support this.

(ii) Seventeen per cent students stated that the energy is destroyed by 'wasteful use', doing work', etc

(iii) Other misconceptions that were also seen were 'body is accelerated due to energy', and 'living bodies have energy'.

(iv) It appears that the media slogans such as 'we should save energy' or 'conserve energy' lead students to think that energy can be destroyed.

Discussion and Implications for Teaching

It appears from comparison of concept maps drawn at two occasions that students' concept of energy is quite stable and does not change in nature qualitatively with time over short interval. Therefore, it could be taken as true reflection of students' view of conception of 'energy'. However, to obtain more exhaustive information about a concept through drawing of concept map, it is useful to provide various dimensions related to the 'concept' in question that are to be considered and depicted on the concept map. Some previous practice in drawing the concept map is also helpful.

Concept mapping has been shown to have positive effect on students' understanding (Goldring and Osborne 1994). Concept maps are also helpful to understand and identify the misconceptions in the mind of students. These are reflected more if students depict qualitative relationship rather than mathematical relationship, such as an equation on the concept map.

Looking at the concept maps drawn by the students, it appears that they confined to what they had studied under the unit 'work and energy' only and did not assimilate what they had studied indirectly about energy in other units. Non-appearance of light, heat and sound as forms of energy in majority of cases is perhaps reflection of this fact. This has the immediate implication that the unit related to energy must be more enriched and it must also establish relationship with concepts appearing in other units as well.

To develop the enriched concept of energy, it is necessary to deal with its five basic aspects (Duit and Orpaz 1983) :

— Conceptualization of energy : What is it?
— Energy transformation : change from one form to another (e.g. changing electricity to heat, etc.)
— Energy transfer, from one place to another
— Energy conservation
— Energy degradation

Unless all of the these aspects are not taken up together formation of the comprehensive concept of energy is not likely to take place In many curricula in India (e g. NCERT, Gujarat State Board, Rajasthan State Board) the concept of energy is dealt within two phases. First phase is taken up at standard IX level. This deals with concept of energy, as required for the basics of physics. The second phase is taken up

at standard X level and deals with sources of energy such as sun, fossil fuels, nuclear energy and related matters However, none of the curriculum takes up degradation of energy, though the concept of energy conservation and energy crisis are discussed in some curricula. This may result in dilemma, as we have observed. Moreover, comprehensive outlook about different aspects of energy is generally lacking. One possibility for this purpose could be in the following sequence :

1. Qualitative discussion about energy : What it does? Different forms of energy and transformation of energy from one form to another. Sources of energy.
2. Conservation of energy (Qualitative and quantitative treatment)
3. Energy transfer, from one place to another
4. First law of thermodynamics : Qualitative discussion
5. Second law of thermodynamics : Qualitative discussion.
6. Entropy and quality of energy : Energy degradation.

While dealing with energy, more emphasis must be given to the understanding of the concepts, rather than solving the problems numerically. At present, conceptualization of energy in the curriculum is mostly related to mechanical energy. (Duit and Orpaz 1983). It needs to be taken care of other kinds of energy at the same time and establishing the relation between them. One could also introduce transformation of energy from one form to another. While dealing with this, one could slowly introduce the concept of conservation of energy. For example, while discussing conversion of electrical energy to heat, one could show that the magnitude of energy in two forms remains the same.

Transfer of energy, from one place to another could be illustrated with the help of various examples. However, it also requires to focus attention on two aspects. One is conservation of energy, which could be further strenghtened, being introduced earlier. The other aspect is degradation of energy. To understand it clearly, one needs to understand laws of thermodynamics. It is necessary to show that though energy is not destroyed, its quality or usability reduces as it flows from higher temperature (level) to lower temperature (level). This is why we need to 'save' energy. It could also be explained here that certain terms have different meaning in physics and in everyday/mass-media communication. Conservation is one such term, apart from work, elastic etc

It appears that teaching of energy is not as simple as it is sometimes taken. It needs thorough discussion on its different aspects and development of curriculum on that basis. Taking it superficially, as is being done in most of the school level curricula, does not do justice with it, particularly in view of its importance in the life of upcoming responsible young citizens of the country.

Acknowledgement : Author is thankful to Sri Ajay George for providing help in collecting the data.

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International Mathematical Olympiad : 1996

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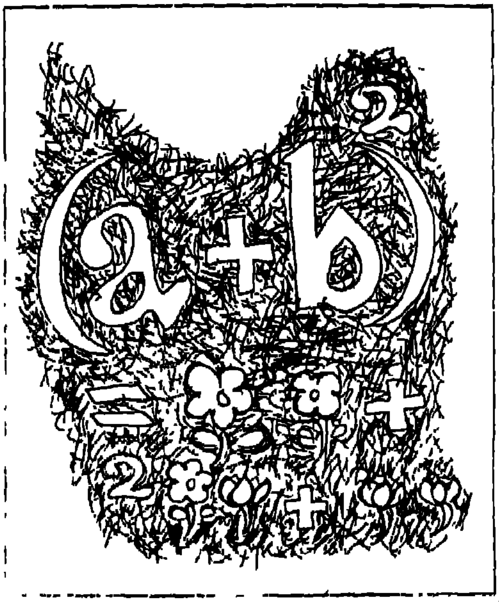

The International Mathematical Olympiad (IMO) is a unique competition to discover, encourage and challenge mathematically gifted young students all over the world. The IMO started in 1959 in Rumania. India's participation in IMO started in 1989. The Indian participation in IMO is sponsored by the National Board for Higher Mathematics (NBHM) of the Department of Atomic Energy (DAE) and the Ministry of Human Resource Development. The IMO held in a different country every year has now become a truly international annual event in which more than 70 countries participate For the first time in the history of the Olympiad, India hosted this event. It was held in Mumbai from 4th to 16th of July. The actual contest was held for two days. Each day the contestants were given three original problems to solve in 4½ hours. This article is a brief account of the entire event

The Indian team of six contestants was selected on the basis of a continuous evaluation of 47 participants at the IMO Training Camp held at the Homi Bhabha Centre for Science Education, Mumbai from May 6 to June 3. All the 47 students were subjected to an intense training two Practice Tests and six Selection Tests during the four-week training. In addition, the team, after selection, was again reassembled at Bhaskaracharya Pratishtan, Pune, from July 1 to July 7, when they were 'warmed up' through four Practice Tests in addition to others by Dr. Katre, the Deputy Leader of the Indian Team for IMO 96, and five other experts, before they actually appeared in Mumbai for the contest.

The IMO question paper was as usual selected by a Jury consisting of all the 75 Leaders of the teams from the participating countries. The selection was done through an elaborate process. On the day of arrival of all the Leaders at the site (namely, the 5th July), they were given a booklet containing 30 problems. The latter had themselves been selected by a Problem Selection Committee, in the course of a month-long work, from out of 108 proposals received from 33 countries. (Following established procedure, India did not send any proposal for a problem). On the

next day, the 6th of July, the members of the Jury received another booklet containing the solution to the 30 shortlisted problems. Neither the Problem booklet nor the Solution booklet indicated the names of the proposing countries of the individual problems. This shortlisting of problems and the preparation of the solution booklet, properly edited and supplemented, wherever necessary, by alternative or modified solutions were made by the Problem Selection Committee consisting of Shailesh Shirali (Chairman), C.R. Pranesacher, B.J. Venkatachala and C.S. Yogananda.

Professors A.M. Vaidya and Shailesh Shirali were the Chairman and Vice Chairman of the Jury respectively. The Jury meetings were held continuously on 6th, 7th and 8th. Several times the Jury had to take votes for taking a decision. Discussions were taken by simple majority votes. The process of selection of the problems for the contest was not easy one because there were several objectives in the minds of the Jury, namely:

1. There should be no repetition or imitation of any question or problem already familiar to any section of students in any of the countries — as could be reasonably established by the Jury
2. The areas of (a) Algebra: Inequalities, Polynomials, Functional equations and sequences; (b) Geometry: Riders of the 'old-fashioned' type, Geometric Inequalities, (c) Number Theory and (d) Combinatorics had to be balanced, in some way acceptable to the Jury
3. The contestants should have a fair test of their mathematical talent and problem-solving ingenuity.
4. The final question paper had to have the prestige of an IMO and should sustain the already high traditions of the 37-year old IMO.

With these four objectives in mind, the Jury underwent a long and tortuous process in intense discussion and debate, followed by propositions after propositions and voting after voting. Finally, the Question Paper, in its English version was ready on the night of the 7th The Paper had six problems. Each problem had a maximum score of seven Problem Nos. 1, 2, and 3 were is increasing order of difficulty, as visualised by the Jury So also were Problem Nos. 4, 5 and 6. At this time the Chairman of the Jury disclosed the names of the countries which had proposed the six problems. This year these turned out to be . Finland, Canada, Romania, Russia, Armenia and France, in the order of the six questions of the final paper.

After this, translations in 45 different languages of the world had to be made, in addition to the translations into the four official languages (other than English), namely, Russian, German, Spanish and French. All this translation work took 24 hours and on the night of the 8th, these translated versions of the Question Papers were approved by the Jury. Further a set of instructions to the contestants for the purpose of their conduct in the Examination Halls was also approved, first in its English version and then in all the other languages. Though there were no official translators employed, some of the leaders like the Russian leader and the Hungarian Leader gave a lot of help in translating many of the proceedings to those members of the Jury who were from East European countries and who had difficulty in understanding English. The 45 translations in the different languages of the world had to be approved mostly by trust. But there were always leaders of neighbouring countries

who could read the languages of their neighbours and make constructive comments on the translation. It was interesting to look into the translations and locate, for example, where the 'if and only if' phrase occurred in the first question in the different languages !

On the 9th afternoon we had the opening ceremony. One important additional parameter in the conduct of this ceremony, was to keep the Leaders physically separated from the Contestants (and the Deputy Leaders, who were all along with the contestants), for obvious reasons, namely, the Leaders were in possession of the Question Papers already. The Question Paper is enclosed.

During the first half hour of each day's contest, any contestant could ask queries pertaining to the question paper supplied to him. On the first day 21 such queries arose and on the second day 51. The answers to these queries were to be decided only by the Jury. For this purpose therefore the Jury had two meetings —one on the 10th and the other on the 11th, right at the site of the examination. The queries were of three kinds: (a) those that pertained to just translation (b) those that pertained to the clarification on the mathematics involved and (c) those that reflected the ignorance of the candidate and tended to, either intentionally or unintentionally ask for help. These three kinds were not always unmixed. Most of the queries turned out to be a blend of all three. The Jury took these queries one by one, in the order in which the volunteers brought it from the halls. The answers were decided by a serious discussion and sent back to the contestant. Very often the answer had to be : 'Read the question again' or 'No comments'. This process took more than the first one hour for the Jury though, as per regulation, no queries were collected from the contestants after the first half hour. As the whole session had to be time-bound, there had to be intense activity to carry all this through.

Note that each contestant was asked to keep his answers to each question in a separate envelope provided for the purpose. Thus after the contest, when all the answer scripts of a particular full team are handed over to the concerned team Leader, he receives 2x3x6 = 36 envelopes. This was done on the evenings of 10th and 11th. By this time the Deputy Leaders also joined the Leaders. The Leader and the Deputy Leader of each country then began to scrutinise the answers of their contestants The actual process of evaluation and grading was then carried out on the 12th and 13th. For this purpose the services of around 36 Indian coordinators (Professors of Mathematics from various parts of India and a few former Olympiad medalists) had been indented. The coordinators were formed into small teams of six each, for each question. Guided by the Chief Coordinator and other members of the Problem Selection Committee each coordinating team formed clear guidelines for marking the scripts. Each country Leader came to them with the six envelopes containing the scripts of his six students for a particular question, spent as much as a half hour with them and at the end of the scrutiny and discussion went back with a firm award of scores on that particular question earned by his students. This process went on in a clock-like schedule for two days, for each of the questions and for each team. There was, however, one exception to this general procedure. The host country's answer scripts were not evaluated by the coordinators only, since both belong to the same country. In pursuance

of the specific regulations of the IMO on this matter, when the scripts of the Indian team were evaluated, the proposer country for that particular question was present, represented by both their Leader and Deputy Leader. In actual practice, the proposer country's Leader and Deputy Leader read the answers of the Indian team and valued them. This evaluation process resulted in the following scores for the Indian team.

Kaustubh P. Deshmukh	7	7	1	7	0	1	23
K. Gopalakrishnan	6	1	6	0	0	1	14
Ashish Mishra	7	0	2	7	0	7	23
Ajay C. Ramadoss	6	1	5	7	5	6	30
Rishi Raj	0	7	4	0	5	7	23
Ashish Kumar Singh	2	1	1	0	1	0	05

The evening of 13th saw the completion of this process for all the questions for all the 75 teams. As these results were being posted on the notice boards as and when they were generated, slowly the trend became clear, namely, this year, the results are going to be poorer in absolute values of scores, than the previous years. Everybody agreed that this year the questions were tougher than the past two years.

Here are some of the highlights on the scores. There was only one perfect score, 42(A Romanian participant). India's best student who had a score of 30 was 11th in rank among all the 424 students. He shared the 11th rank with six others. The 10 higher ranks were shared by 24 participants. Question Nos. 3,5 and 6 had poorer scores and of these, Question No.5 was really very poorly answered. It actually proved to be a 'disaster' in the words of the Chief Coordinator There were only six perfect scores on this question and the number of students who scored only a zero was the largest for this question, as large as 308. Question No.6 which was given that position in the question paper because it was considered the most difficult, turned out to be the other way. It had the maximum number (namely 99) of perfect scores (that is, a score of 7)

The Regulations of the IMO require a proportion of not more than one-twelfth of the candidates to be awarded a first prize (Gold medals), not more than one fourth to be awarded first and second prizes (Gold and Silver medals) and one half to be awarded first, second and third prizes (Gold, Silver and Bronze medals). Remembering this, the faculty participants of the IMO were gradually becoming aware of the likely distribution of the prizes and the possible cut-off points for the medals, as the scores were gradually being unravelled on the notice boards This gradual unveiling of the final scene was itself a thrilling experience. On the night of the 14th July the Jury of IMO '96 had its last meeting. It decided on the distribution of the prizes as follows :

28-42	First Prize
20-27	Second Prize
12-19	Third Prize

This resulted in 35 Gold medals, 66 Silver medals and 99 Bronze medals. No special prizes were awarded this time for any distinguishing solution, though, for Question Nos 1 and 2 there were several solutions revealed by the answer scripts. Question No.2, for example, had 20. The topper of the entire Olympiad, a Romanian student, who scored 42 (out of maximum of 42), gave a solution to Problem 1, which along with many others were considered for a special prize. But finally, the decision was not to award any special prize.

Also unofficially India was ranked 14th among all the countries The ranking is un-

official because the IMO rules do not provide for any such ranking. But it is customary to add all the scores of the individual participants of a country's team and the resultant total score is usually taken as the score of the country. The maximum possible such score for a country is 252. Romania which scored 187 was the first this year. The hierarchy of the top 20 countries came out as follows :

1	Romania	187
2	United States of America	185
3	Hungary	167
4	Russia	162
5	United Kingdom	161
6	China	160
7	Vietnam	155
8	Republic of Korea	151
9	Iran	143
10	Germany	137
11	Japan	136
12	Bulgaria	136
13	Poland	122
14	India	118
15	Israel	114
16	Canada	110
17	Slovak Republic	108
18	Ukraine	105
19	Turkey	104
20	Taiwan	100

The marathon work done by the coordinators in the grading process both in the actual physical volume of work and in the management of the process in terms of cooperative involvement in the work vis a vis the Leaders and Deputy Leaders of the different countries was appreciated by one and all. The Leader of the Indian Team was particularly impressed by the cooperation and concern which the six Leaders of the proposer countries showed towards the Indian students' scripts.

Thus the IMO '96 ended with five medals for India which included one Gold. This is the second time India gets a Gold Medal in the history of its participation since 1989. Since the IMO is a prestigious mathematical contest for students below 20 years who have not yet commenced their undergraduate education, this writer appeals to all higher secondary schools to bring this to the notice of all their students. There is no fixed syllabus. Sound knowledge of Mathematics upto Class X should be enough (It is interesting to note that one participant in India's Team for IMO '96, Rishi Raj, was only a ninth standard student) However this knowledge should be of depth and a problem solving skill is necessary. Watch for the next announcement of Regional Mathematical Olympiads in your region sometime in October-November 1996, which will start the process of selection for the team of 1997 who will represent India in IMO '97 to be held in Argentina in July 1997. For further details write to the IMO Cell, Departments of Mathematics, Indian Institute of Science, Bangalore 560012.

SCHOOL SCIENCE DECEMBER 1996

37th International Mathematical Olympiad

5-17 July 1996, Mumbai, India

First day (10 July, 1996)

Time : 4½ hours *Version* : English

1 Let ABCD be a rectangular board with $|AB| = 20, |BC| = 12$. The board is divided into 20x12 unit squares. Let r be a given positive integer. A coin can be moved from one square to another if and only if the distance between the centres of the two squares is $\sqrt{r}$. The task is to find a sequence of moves taking the coin from the square which has A as a vertex to the square which has B as a vertex.

(a) Show that the task cannot be done if r is divisible by 2 or 3.

(b) Prove that the task can be done if $r = 73$

(c) Can the task be done when $r = 97$?

2. Let P be a point inside triangle ABC such that

$$\angle APB - \angle ACB = \angle APC - \angle ABC$$

Let D, E be the incentres of triangles APB, APC, respectively. Show that AP, BD and CE meet at a point.

3. Let $S = \{0,1,2,3\ldots\}$ be the set of non-negative integers Find all functions f defined on S and taking their values in S such that

$$f(m + f(n)) = f(f(m)) + f(n) \text{ for all } m, n \text{ in } S$$

Each problem is worth 7 points.

Second day (11 July, 1996)

Time : 4½ hours *Version* . English

4. The positive integers a and b are such that the numbers $15a+16b$ and $16a - 15b$ are both squares of positive integers. Find the least possible value that can be taken by the minimum of these two squares.

5. Let ABCDEF be a convex hexagon such that AB is parallel to ED, BC is parallel to FE and CD is parallel to AF. Let R_A, R_C, R_E denote the circumradii of triangles FAB, BCD, DEF respectively, and let p denote the perimeter of the hexagon. Prove that

$$R_A + R_C + R_E \geq \frac{p}{2}$$

6. Let n, p, q be positive integers with $n > p + q$. Let $x_0, x_1, \ldots, x_n$ be integers satisfying the following conditions :

(a) $x_0 = x_n = 0$,

(b) for each integer i with $1 \leq i \leq n$

either $x_i - x_{i-1} = p$ or $x_i - x_{i-1} = -q$

Show that there exists a pair (i, j) of indices with $i < j$ and $(i, j) \neq (0, n)$ such that $x_i = x_j$.

Each problem is worth 7 points.

An Experiment with Rate-Centred Learning in Science Using Graded Worksheets at Middle School Level

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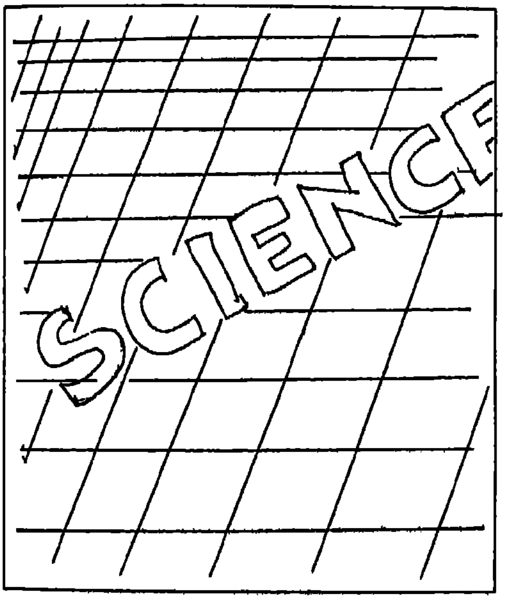

Even a cursory look at our academic environment in schools will reveal that it is afflicted with a number of maladies. First of all, our learning environment is aimless as no standards and specifications have been laid for it. Secondly, it encourages rote learning and kills the element of original thinking among children. Thirdly, it is inefficient as it lacks the optimal use of available resources. Fourthly, our teaching methods lack depth due to over-emphasis on content learning as compared to process learning. And lastly, our teaching methods are highly impersonal and hardly any individual guidance or corrective feedback is given to students.

Now the question arises that should we, in our capacity as teachers and educators, accept teaching with some or all these serious maladies. The answer to this question should be an emphatic 'No'. In order to remove these maladies, we must make our instruction learner-directed by training our students in the learning skills i e. learning how to learn. In other words, we must create a learning environment in which students take up more and more responsibility for their own education.

Issues Concerning Learner-Directed Instruction

For achieving the aim of making our classroom instruction learner-directed, the following issues need to be tackled.

1. Is the instructional method used in school purposefully directed toward achieving the intended aims?
2. How effective can be the learner-directed instructional method for both the slow and fast-learners?
3. Does the learner-directed instruction motivate students?
4. Does the learner-directed instruction respond to some individual differences among students?

Some educators have tried to probe into these issues and their studies (Carroll, 1963 and Bloom, 1968) show that these issues can be easily tackled even by average teachers.

Advance Organisers : Aids for Learning Direction

With the resources that are obtainable in most schools in our country, the learner-directed instruction can be easily implemented if the teacher pays deliberate attention to the following advance organisers:

1. Creation of learning environment with corrective feedback and individual guidance.
2. Formulation of an instructional method that encourages self learning.
3. Generation and sustenance of motivation in learning
4. Specification of performance level for students
5. Allowance for rate-centredness in learning

The teaching methods based upon the above-mentioned advance organisers can be helpful in effective learning by students by manipulation of media, modes and environment so far as it reflects on learning (Khanam and Bhushan, 1978).

A Step Toward Learner-Directed Instruction: Rate-Centred Learning Approach

An attempt has been made by the investigator to shift the emphasis to rate-centred self-learning in science at the grade level six in the Kendriya Vidyalaya No.2, Bathinda by preparing and implementing the structured and sequenced worksheets. The instructional method chalked out for the Rate Centred Learning Approach (RCLA) is shown in Fig.1. It is an adapted version of the individualised guided system of instruction developed by the NCERT. The RCLA illustrated in Fig. 1 reveals the following steps in this learner-directed instruction.

1. The learner interacts with the study unit in the textbook for processing information in the form of finding key words, key phrases and key sentences after a demonstration in this respect by the teacher.
2. After processing the information, the learner attempts the questions given in the worksheet on that study unit. He does it at his own rate of learning.
3. The learner interacts with the fast-learners (peers) and the teacher on an individual basis to get his learning difficulties removed.
4. The learner consolidates the information processed and written by him in the worksheets.
5. The learner is evaluated by the fast-learners or the teacher and is given corrective feedback
6. On successful performance, the learner is given the next worksheet.

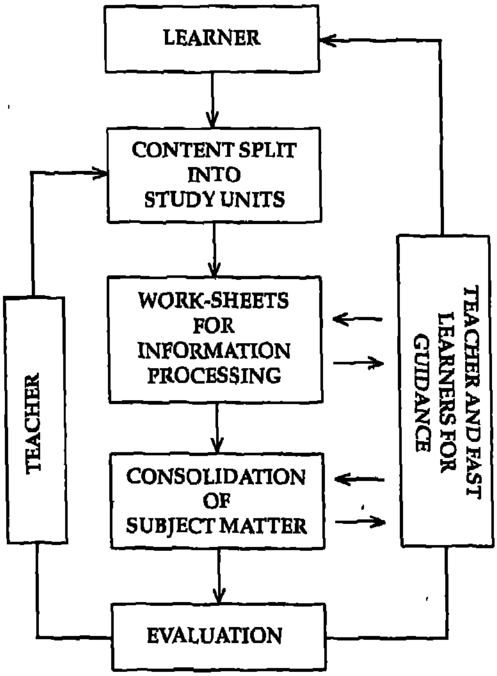

Fig.1 : A Simple Rate-Centred Learning Approach

Thus, the RCLA is a self-paced procedure in which a student learns at his own pace; decides when he is ready for the next assignment; and takes guidance from his peers and teacher.

The Experiment with RCLA

In order to develop, try-out and determine the efficacy of the RCLA, an experimental study was undertaken in Kendriya Vidyalaya No.2, Bathinda. The experiment was conducted to find the effect of RCLA upon achievement and students' reactions towards it.

For developing the rate-centred self-learning science worksheets, the sequentially structured questions were prepared and duplicated for use by the students of grade level six (N=100; Age : 11+). The worksheet has questions paragraphwise on textual material of the prescribed science book. This was done to facilitate information processing and fill in the worksheets by students on their own.

The first two lessons of Class VI science textbook were taught by the conventional method and students were tested on a teacher-made test having a discriminatory index of 0.4. This was followed by a four-week implementation of the RCLA. The 'before-and-after' design of study was used to find the effect of the RCLA on achievement of students. For the after-treatment achievement score, again a teacher-made test with discriminatory index of 0.45 was used. These two tests were integrated into the unit test plan which is being followed in all the Kendriya Vidyalayas throughout the country.

Also, the students' reactions towards the RCLA were collected on the three-point scale, i.e. favourableness; indifference and unfavourableness by dividing students in three groups of thirty each representing the high achievers, middle-achievers and low-achievers. Further, the students' comments were collected to know their attitude towards the programme.

Analysis

To analyse the effect of the RCLA upon achievement, the unit test scores of students before and after the implementation of the approach were analysed using the t-test technique The results of the t-test analysis of achievement score are shown in Table 1.

TABLE 1
Summary of the T-Test Analysis of the Achievement Scores (M.M. = 50, Age: 11+)

Situation	*N*	*M*	*S D.*	*t-Value*
Before	100	31	9.4	7.3*
After	100	42	8.7	

* Significant at .05 level

The table reveals that with the implementation of the RCLP, the students' achievement scores improved at .05 level of significance.

Further, the students' reactions towards the RCLP were analysed using the chi-square technique and results of the same are summarised in Table 2.

TABLE 2
Summary of the Chi-Square Analysis of Students' Reactions toward the RCLP (d.f.4)

Group	*Reactions of students'*			x^2
	Fav.	*Indiff.*	*Unfav.*	
High	20	8	2	
Middle	22	6	6	7.6**
Low	16	10	4	

Chi-square = 7.6
** Level of significance : .01

The table reveals that students were overwhelmingly in favour of RCLP at .01 level of significance as compared to conventional methods of teaching.

The students were asked to write their comments on the RCLP. Some of the typical comments of the students were as follows :

1. Through this method, I have found that more than fifty per cent of the subject matter I can learn myself.
2. The course has given confidence that I can learn independently.
3. In this method, other students and the teacher become helpful in studies.
4. I can get my difficulties removed in the classroom itself, that is a good point of the course.
5. I feel nice in this course as there is no hurry to finish the course
6. I find it easy to revise my studies in this method
7. Initially, I was nervous as I was to learn things myself but it became alright later on.
8. I find this method no better than the lecture-method we were following earlier.

Thus, there are more positive comments by the students on RCLA. Furthermore, the RCLA is cost-effective, as the duplication of the worksheet can be done as a part of SUPW by students. It was done on the present experiment. Also, the implementation of the RCLA does not require any special teacher competencies and re-orientation.

High-points of the Innovation

The innovation of RCLA which was implemented in the Kendriya Vidyalaya, Bathinda, by the investigator who was given eleven class periods a week, showed the following high-points during its try-out :

1. It proved to be well adapted to the real situation as it required no new teacher competencies.
2. It gave an insight into self-direction and information-processing to the students.
3. It did not require extra expenditure as the notebooks were replaced by graded worksheets.
4. It produced adequacy in learning as children learnt at their paces and got individual guidance
5. It standardised the classwork for the three sections of the grade level six in the school.
6. It provoked a mixture of healthy competition and cooperation.
7. It provided a motivation to students to learn faster and better.
8. It produced a facilitative learning environment in the classroom.
9. It resulted in a demand for extending the RCLA procedure to other subjects.
10. It got the school good comments from the school inspectors.
11. It spread to the other four local Kendriya Vidyalayas as the RCLA became a talking point among parents.

Implications

The success story of the innovation of RCLA indicates that there is a need for adopting such programmes. Such programmes can be helpful in breaking the inertia of teachers and infusing a new vigour in the classroom environment. In respect of the success of an innovation, Merill (1977) says that the adaptability is synonymous with innovativeness, and therefore, the institutional climate must provide a setting wherein innovativeness can flourish

According to Kishore (1988), a newer method of instruction or innovation in education is not just a novelty but a deliberate

effort to introduce a specific new practice for achieving the academic goals efficaciously.

It is to be borne in mind that an educational experiment in the school regarding development and tryout of innovation like the RCLP should be a systematic self-critical enquiry supported by a well-prepared strategy Before implementing an innovation at the larger scale, it should be tried-out as pilot programme for three to four weeks to refine and strengthen it.

In this world of information and knowledge explosion, the efficient and effective methods of self-instruction have acquired a great significance. The RCLP can be a small but practicable step in shifting the emphasis from teacher-directed instruction to student directed instruction.

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Attitude of Primary School Teachers towards Mathematics – A Study

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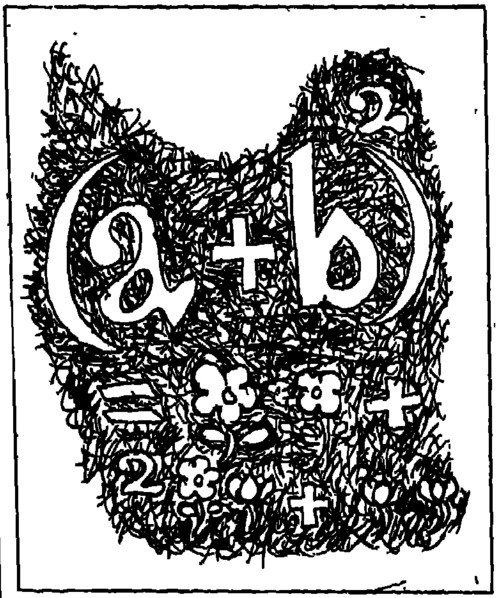


Mathematics is considered as the most important subject of studies and that is why it has been made a compulsory subject upto the secondary level. There is a feeling that mathematics is a dull and boring science. The other viewpoint is that it is a very interesting subject but very difficult and complicated which is beyond the reach of an ordinary person. Such existing nations make the attitude of teachers and learners unfavourable towards mathematics.

The environmental, social and physical setting which are present around the individual influence him to develop an attitude in a favourable or in an unfavourable direction. Attitude of teachers influences the effectivity and behaviour of not only the teacher but also the behaviour of his students. Ahuja (1995) confirms that more favourable attitude facilitates change in teaching behaviour. Mathematics is considered as dull, boring, difficult and complicated subject and ultimately these feelings among the mass make their attitude unfavourable towards the study of mathematics.

Imparting mathematics education is the direct responsibility of the mathematics teacher at secondary level. At the primary level it is the responsibility of all the teachers because at this stage almost all the teachers teach mathematics in one class or other. Hence primarily, the teachers themselves should possess highly positive attitude. It is logical to expect that all the primary teachers should possess a high level of positive attitude towards mathematics.

In the process of identifying the goals of mathematics education most of the researchers, policy makers, teachers, teacher educators and scholars have made a mention of attitude towards mathematics. A mathematics teacher can provide proper atmosphere in the classroom to inculcate favourable attitude towards mathematics amongst the learners who blossom into citizens. This is possible only when the teachers themselves possess favourable attitude towards mathematics irrespective of their subject of teaching.

There are certain traits which are essential for successful teachers and which make them popular among the pupils. Among these traits favourable attitude towards the teaching subject is most important. The study of Wickman (1928) shows that children imitate the behaviours of admired teachers Morse and Wingo (1968) conclude that well-liked teachers make well-liked subjects, that study of such subjects is continued by students, while subjects taught by disliked teachers are continued only if they are required. Chhaya (1974) finds that effective teachers have more favourable attitude towards teaching. Awasthi (1989) concludes that the popular teachers have liberal attitude towards things.

All these findings have motivated the researcher to study the attitude of teachers towards a subject if great utilitarian value i.e. Mathematics It is a psychological fact that favourable attitude can be inculcated better among the learners in their childhood; and teachers can play a vital role in this direction. These two factors served as the guiding principles to choose to study the primary teacher's attitude towards mathematics. The researcher is of the view that the attitude towards mathematics of primary teachers is not as favourable as is essential for the proper transaction of mathematics education.

Objectives

The objectives of the present study are :

O_1. To categorise the primary school teachers as low, average and high on the basis of their attitude towards mathematics.

O_2. To study the attitude of male and female primary school teachers towards mathematics.

O_3. To study the attitude of primary teachers serving in government and private schools towards mathematics.

Hypotheses

Following hypotheses were formulated for the study :

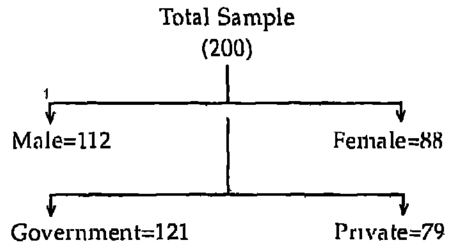
H_1 A few primary school teachers possess a high favourable attitude towards mathematics.

H_2 Male and female primary school teachers do not differ significantly in their attitude towards mathematics.

H_3. Teachers in government and private primary schools do not differ significantly in their attitude towards mathematics

Methodology

Sample : Using stratified random sampling, two hundred primary school teachers from 30 schools (Male-17, Female-13, Private-12, Government-18), of Bharatpur district, were taken as the sample of the study.



Tool Used

Wikert type Attitude towards Mathematics Inventory developed by Lalit Kumar was used for the data collection.

Procedure

Attitude towards mathematics inventory was administered on 200 primary school teachers of 30 primary schools and scoring (Ranging from 0 to 96 marks for all the

24 items) was made. On the basis of the total scores of each individual in different chosen group, the teachers were categorised as low scorer who achieved less than 60 per cent (less than 58 marks). Teachers getting between 60 per cent to 75 per cent (58 marks to 72 marks) were considered as average scorer and the teachers having more than 75 per cent (73 marks and above) were taken in the category of high scorers. The t-ratio was calculated to test the significance of difference between (1) Male-Female and (2) Government-private schools for all the three groups of teachers i.e. Low, Average and High and also for the total score. Out of a total of 200 teachers 97(48 50 per cent) teachers were found as low scorer, whereas 68 (34.00 per cent) and 35(17 50 per cent) teachers were found as average and high scorer respectively. Percentage of low, average and high scorer teacher for each section (Male-Female, Government - Private) was calculated for analysis.

Results and Discussion

TABLE I
Number and Percentage of Low, Average and High Scorer Teachers

Category	*Low*	*Average*	*High*	*Total*
Male	53 (47.32%)	38 (33.93%)	21 (18.75%)	112 (100.00%)
Female	44 (50.00%)	30 (34.10%)	14 (15 90%)	88 (100 00%)
Government	61 (50 41%)	41 (33.89%)	19 (15.70%)	88 (100.00%)
Private	36 (45.57%)	27 (34.18%)	16 (20.25%)	79 (100.00%)
Total	97 (48.50%)	68 (34.00%)	35 (17.50%)	200 (100.00%)

Table I reveals that the percentage of low scorer ranges from 45.57 per cent (Private) to 50.41 per cent (Government), whereas percentage of average scorer ranges from 33.89% (Government) to 34.18 per cent (Private) percentage of high scorer ranges from 15.70 per cent (Government) to 20.25 per cent (Private).

It is clear from the table that more primary teachers possess low level of attitude towards mathematics and very few teachers possess high level of attitude towards mathematics. The difference between the maximum and minimum percentage is wider in low and high group, whereas it is narrow in the average group.

TABLE II
Mean, S.D. and t-value between Male and Female Teachers

Group	*Category*	*Mean*	*S D.*	*N*	*t*	*Level of significance*
Low	Male	43.13	7 56	53	5.29	0.01
	Female	49.63	7.96	44		
Average	Male	65.01	7.34	38	1.35	Not Significant
	Female	67.39	7.31	30		
High	Male	86.06	5.75	21	2.38	0.05
	Female	79.93	6.56	14		
Total	Male	59.24	11 39	112	0.98	Not Significant
	Female	60.82	11 03	88		

Table II reveals that the obtained t-value (5.29) between male and female of low attitude towards mathematics groups was found significant at 0.01 level (df=95) of significance. It indicates that the male and female group differ significantly in their attitude towards mathematics. The female group was found superior on mean value ($M_2 = 49.63$) in comparison to the male group ($M_1 = 43.13$). t-value (2.38) between male and female of high attitude towards mathematics group was found significant at 0.05 level (df=33) of significance. The male

group was found superior on mean value (M_1=86.06) in comparison to the female group (M_2 = 79.93).

The t-value between male and female for average (1.35) attitude towards mathematics groups and also for total (0.98) attitude towards mathematics groups were found not significant. It indicates that male and female do not differ significantly in their attitude towards mathematics.

TABLE II
Means, S.D. and t-value between Male and Female teachers

Group	*Category*	*Mean*	*S.D.*	*N*	*t*	*Level of significance*
Low	Govt.	51.18	7.03	61	3.12	0.01
	Private	46.35	7.54	36		
Average	Govt.	66.43	6.75	41	1.62	Not Significant
	Private	69.16	6.90	27		
High	Govt.	77.69	6.08	19	4.12	0.01
	Private	87.03	7.13	16		
Total	Govt.	61.21	11.96	121	1.60	Not Significant
	Private	63.94	11.79	79		

Table III reveals that the calculated t-value (3.12) between teachers of government and private schools for groups having a low attitude towards mathematics was found significant at 0.01 level (df=95) of significance. It indicates that the government and private school groups differ significantly in their attitude towards mathematics. The government school group was found superior on mean-value (M_1=51.18) in comparison to the private school group (M_2 = 46.35). t-value (4.12) between teachers of government and private schools having a high attitude towards mathematics was found to be significant at 0.01 level (df=33) of significance. The private school group was found superior on mean value (87.03) in comparison to the government school group (77.69).

The t-value between teachers of government and private schools for groups having an average (1.62) attitude towards mathematics and also for total (1.60) attitude towards mathematics group were found not significant. It indicates that government and private school teachers do not differ significantly in their attitude towards mathematics.

General Conclusions

G1 A few primary school teachers posses high favourable attitude towards mathematics.

G2 Male teachers are superior in high attitude group where as female teachers are superior in low attitude group. They do to differ significantly in average and total groups.

G3 Private school teachers are superior in high attitude group where as Government school teachers are superior in low attitude group. They don't differ significantly in average and total groups.

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Science News

Gamma Ray Bursts Detected by Indian Scientists

SROSS-C-2 Satellite launched by India in 1994 has successfully detected bursts of gamma rays from space. The source of these gamma rays are the subject of intense international inquiry.

The gamma ray bursts (GRBs) are emitted from unknown sources spread all over the sky. These are intense blasts of gamma radiation that last from a tenth of a second to a minute.

GRBs were first found by U.S. Vela satellite in 1967. At present they are being detected everyday by the Compton gamma ray observatory in the USA. These extremely high-energy bursts continue to remain one of the long-standing mysteries of astrophysics.

An Indian Space Research Organisation (ISRO) scientist has reported that SROSS-C-2 satellite has detected 11 GRBs in the eight-month period since it was put in its orbit in July 1994.

The sensitivity of the GRB instruments on board the Indian satellite allow detection of 18 events every year. Reporting details in *The Indian Journals of Radio and Space Physics*, the ISRO scientist, Mr. T.M K. Marar, said the GRB experiment on SROSS-C-2 satellite will continue for the next five years of its life.

Most of the GRBs detected by the ISRO satellite have been confirmed by other international satellites. The ISRO's GRB detector on SROSS-C-2 satellite consists of a 76-mm-diameter scintillation crystal with an associated microprocessor-based circuitry. The output signal is proportional to the incident gamma ray energy and gives information on the intensity and energy of gamma rays.

SROSS-C-2 is expected to partially fulfil the need for additional GRB detectors in the near-earth orbit to provide a complete coverage of the sky at all times.

At present Compton gamma ray observatory of the USA and India's SROSS-C-2 satellite in near-earth orbit Russia's Granat satellite, the international Ulysses probe and wind spacecraft carry instruments that can form the interplanetary network of GRB detectors.

Indian space scientists hope to eventually join an interplanetary network of American, Russian and other satellites to track down sources of gamma ray bursts (GRBs).

Scientists hope that many GRB sources may be localized accurately in future and eventually identified. According to some theories, GRBs occur due to fall of a comet

or an asteroid onto a neutron star and subsequent explosion, or neutron star quakes, and neutron star-black hole mergers.

Gene Code of New Life Form Uncovered

Scientists have decoded the genes of a microbe that lives on the ocean floor, can survive only in near-boiling water and thrives on carbon dioxide. The study confirms existence of a third major branch of life.

A team of researchers from three institutions has announced that they have decoded the 1,700 genes of a microbe called "methanococcus jannaschii." It has been found to be a member of a branch of life called archaea.

This is a very different life form from the ones that are known today. Two-third of the genes in this organism are new to science and biology.

This finding proves that the microbe is a member of a class different from the two other basic branches of life—bacteria and eukaryotes, which include plants, animals and humans.

Cellular structure is the main difference between these forms of life. The cells of eukaryotes have nuclear structures. Bacteria do not. The archaea has some characteristics of the other life forms, but is fundamentally different in the way it functions and lives.

The existence of archaea as a third branch of life was first proposed by Carl Woese and Ralph S. Wolfe of the University of Illinois, Urbana, in 1977.

Their conclusion was greeted with skepticism and only recently has it gained acceptance as more and more of the strange new form of life has been found in places where no other type of life can survive.

Archaea include microbes that live at the extremes of the planet – the very, very cold, hot or high pressure place that no other form of life could endure.

Some scientists have suggested that archaea may represent the earliest form of life and that it may be the most likely form of existing on other planets. Its precise position on the tree of evolution is still uncertain.

Indian Seismic Observatory Planned in Antarctica

India will establish a seismic observatory in Antarctica near its permanent station "Matri" during its 16th expedition to the icy continent in the first week of December, 1996.

Indian will operate the broad band digital seismic observatory to monitor and study seismic activity in and around Antarctica, to determine hypocentres of earthquakes occurring throughout the world.

At present seven countries have seismic stations with digital broad band seismographs in Antarctica, which was considered till 1960 as an aseismic area (free from seismicity) but subsequent observations brought to light moderate seismicity of the continent, according to Dr. S.C. Jain, a senior scientist of the National Geophysical Research Institute (NGRI).

The 16th Indian Expedition Team would comprise 58 members including scientists from NGRI. It would be headed by Dr. A.L. Koppar of the Indian Meteorological Department.

Geophysical investigations have been an integral part of India's research programme in Antarctica right from the initial stages. The initial investigations were confined to the icy-shelf region where the

first Indian station, "Dakshin Gangotri" was located. After the commissioning of Maitri, helicopter-borne and helicopter supported surveys have also been conducted over the glaciated region.

NGRI after extensive studies on the rocks collected from Antarctica found chemical similarities with the ones found in the country's eastern ghats. Further studies to support this theory through structural and geochemical tests are in progress.

The first geophysical survey over the ice shelf was conducted during the second expedition. In this study eight magnetic profiles were recorded to study the magnetic characteristics of the bedrocks beneath the ice-cover.

The magnetic profiles in the Schirmacher region have been surveyed in subsequent studies.

During the geophysical studies in the Schirmacher Oasis region, three magnetic traverses totalling about three line km with average station interval of seven meters and six short of criss-crossing magnetic profiles totalling over 2 km were measured.

Study of the (low energy) radioactivity of water samples collected from the lake also revealed that the water did not contain any hazardous radioactive contaminations.

Geochronological studies were also carried out on 9 rock samples collected from the region. Four of these samples belong to the crystalline basement forming part of the east Antarctic shield while the other samples were of the dolerite dykes occurring in the region.

Breakthrough in Treatment of Paralyses Due to Injured Spine

Thousands of people world over suffer from spinal damages due to accident or disease. Most of them have to suffer for their life time as no permanent remedy is available in spite of researches going on for many years.

Recently a breakthrough in spinal injury research has been made by scientists They have been able to restore movement to the legs of paralysed animals.

The achievement is being hailed as a milestone in the quest to find a treatment of spinal injury.

The pioneering research is done by a team at the Karolinska Institute in Stockholm, Sweden. The technique is based on a new way of rerouting severed nerve fibres from the injured area.

Nerves or axons in the spinal cord travel up and down in the outer layer of the cord in the white matter. Previous attempts to reconnect broken nerve fibres directly have failed.

The success eluded scientists until now because it was found that the white matter secretes a protein that inhibits growth.

In the new technique this problem has been overcome by linking broken fibres into the central area of grey matter. That is bypassing the inhibiting protein.

A substance called fibrin glue, similar to the material that causes blood to clot, is pumped over the area to hold in place the bridges between the severed nerve fibres and the grey matter.

The glue also contains large amount of a natural chemical that boosts nerve cell growth.

The scientists have found that within few days, the broken nerve fibres invade the "bridge" and grow into the central spinal cord. Exactly where the new, growing fibres go and how they connect to nerves controlling the leg muscles is uncertain.

El Nino Linked with Culture

El Nino is a weather event every few years in which pools of warm Pacific water shift and winds change over the Pacific Ocean, bringing heavy rains to the coast of northern Peru and reducing the available fish in the region.

The phenomenon was named El Nino by Peruvian fishermen because, when it occurs, the first effects generally become noticeable around Christmas. El Nino, meaning little boy in Spanish, is also used to refer to the baby Jesus.

El Nino's effects on upper-air wind currents result in weather changes around the world. Impact can include storms in California, drought in Brazil, Africa and Australia and severe storms in the central Pacific.

The El Nino weather events can cause so much disruption around the world. It is believed that its occurrence began about 5,000 years ago. According to a team of researchers, the shift in climate may help explain cultural changes going on at the same time.

Archaeologists and climate experts studying fossils in Peru have found that these fossils indicate that until 5000 years ago, the area had a relatively stable tropical climate with little year to year variations.

According to scientists, the cultural changes that took place at that time are linked with the emergence of El Nino events. Although climate does not drive culture but certainly changing climate requires adaptations. Archaeological findings confirm that shortly after 5,000 years ago, Peruvians began to build large temples along the coast. The cultural change at that time is more or less true of much of the early Americas. It was a time when cultures began to show greater complexity.

The paleontological (fossil) evidence has not been very clear on the issue, as to when El Nino events came into being.

The earth's orbit was somewhat different before 5,000 years ago, said Mr. Kutzbach, who has also done El Nino research. But, he added, "the changes in the earth's orbit are gradual, so they don't explain a threshold of why, at around 5,000, there would have been a change".

The new report extends knowledge of the El Nino back considerably from written records of the event, which began in the 1500s with the arrival of Spanish explorers in the Americas. During the period from 8000 years to 5000 years people in most part of the world were settling down in farming villages Perhaps it had been made possible by a stable climate conditions. However, when El Nino events with great climate variability entered the system 5,000 years ago, it may have created an opportunity for new solutions for new climatic problems.

Ozone Layer Still under Threat

Experts have warned that the depletion of the ozone layer of the atmosphere may continue for some more time in spite of the provisions of Montreal Protocol. It has been predicted that the ultraviolet radiations that will reach the earth in the next two years are likely to increase by a factor of 8% to 15% due to the depletion of the ozone layer.

If all Montreal Protocol provisions are adhered to, peak loading of ozone depleting substances and peak depletion of ozone are expected around 1988.

The ozone layer is present in the upper atmosphere — about 10-15 km above

the earth – and it acts as a screen which prevents the harmful ultraviolet radiations from reaching the earth.

Ozone is continuously formed and destroyed naturally in the atmosphere and the two processes are in equilibrium, but lately certain human activities have disturbed the natural equilibrium. These activities release chemicals which destroy ozone. So more ozone is destroyed than is created. Ozone Destroying Substances (ODS) (like freon) are used in certain refrigerators and other cooling appliances, manufacturing of foam articles, industrial appliances, fire extinguishing systems and some cosmetics and health products.

At present the ozone layer continues to be depleted over much of the globe. The rate of depletion is about 5% per decade over the northern and southern mid-latitudes. Atmospheric chlorine levels continue to increase but at a slower rate than the 1980s (2.9% in 1989 vs. 1.6% in 1994).

This reduction is due to international pressure to tackle the problem. With continued compliance of the Montreal Protocol, chlorine loading is expected to peak around 1998 and a slow recovery would follow over the next 50 years.

Experts, however, have warned that if the Montreal Protocol was not complied chlorine levels in the stratosphere will increase to 9% over the next 50 years.

The total global ozone loss amounts to nearly 7% over the decade over Antarctic, however, there is a depletion of about 80% from only September to October last year. In the Arctic region, there is depletion up to 50% from January to March last year.

Environmentalists say that every 1% depletion of ozone leads to 1.3% to 1.8% increase in ultraviolet radiations reaching the earth surface.

Experts believe that around 1988 there would be 1.5% ozone loss in the northern mid-latitudes in summer, 2.5% in winter spring, and an equivalent 2.5% loss in the southern hemisphere all year round

Pemphigus is Curable Now

A team of doctors led by Dr. J.S. Pasricha and Dr. Ramji Gupta of the All India Institute of Medical Sciences (AIIMS) has achieved a major medical break through by devising a drug regimen to cure pemphigus. The "pulse therapy" technique developed by them have already established its effectiveness on more than 300 patients of pemphigus.

The breakthrough holds great significance for this country because Indians are more prone to the disease than any other group because of genetic factors.

Pemphigus is a painful and fatal skin disease which mostly afflicts Indians because of genetic factors. Prevalence of disease is highest amongst Gujaratis and Assamese in India. A patient of pemphigus may develop disfiguring blisters, ulcers and ruptures all over the body. Uptill now there had been no method known to cure the disease. The patients were doomed to die of the disease or corticosteroids and immunosuppressant drugs which were given to them as standard technique.

The new technique also uses the same drugs but differs in the administration which calls for massive but spaced doses which appear to shock the immune system into behaving itself rather than devouring the victim's skins which is what pemphigus is all about.

Over the past 15 years, the AIIMS team led by Dr. Pasricha enrolled 500 patients for pulse therapy and succeeded in fully

curing 300 of them while the others are in various stages of recovery rather than facing death and extreme discomfort.

Not only did the technique dramatically reduce the suffering of pemphigus patients but it turned out to be a complete and reliable cure for a disease which is known for capricious relapses apart from being fatal.

According to Dr. Gupta, a pemphigus patient could be cured completely if he could be treated with a specified amount of drugs and subsequently the dexamethasone-cyclophosphamide pulse therapy regimen could be formulated.

The advantage with pulse therapy is that the drugs do not accumulate in the body and cause the side-effects associated with immuno-suppressants (cyclophosphamide) and corticosteroids (dexamethasone).

Success, however, depends on regularity of administration at fixed intervals under close supervision. Patients need to spend very little time at a hospital compared to the several months they earlier required.

Book Review

Solved Problems in Physics

By S.L. Srivastava, Price not mentioned; publisher Tata Mcgraw Hills, 1995, pp 375.

The books under review is one of the publications brought out every year to help students who wish to adopt easier options to compete in entrance examinations for various professional courses after completing Senior Secondary stage.The main purpose of the book, according to the author, is to provide a set of well-designed solved problems, arranged in hierarchical order of difficulty so as to help students to develop a proper understanding of concepts in physics. The tacit assumption behind this approach has been that the solved numerical problems not only provide a key to develop proper comprehension of the concepts of physics but also serve as a useful tool to further clarify understanding and remove their doubts if any.

The book includes a little over 600 problems based on various concepts of physics that are taught at the Senior Secondary level These problems have been arranged under seventeen major topics which encompass most of the topics prescribed by different State Boards of Education and the C.B.S.E. Some major topics which do not figure in the book are wave motion, electromagnetic waves, wave optics, nuclear physics, solid state physics, modern electronics and the universe. As the title of the book suggests, majority of the problems given in it are in the forms of numericals with only a few problems meant for testing applications of the concepts of physics. It also does not include problems concerning plotting and interpretation of graphs, vectors and drawing skills.

The problems selected under each topic are appropriate and adequately cover the concepts in that topic. The author has been successful in developing problems of different difficulty levels and grading them accordingly. A number of problems involve derivation of relations between various parameters from the formula; equations and expressions generally derived in standards textbooks while some others require use of more than one concept to arrive at the solutions. This may serve as a useful guide to develop a proper understanding of the concepts of physics In general, the solution follows the statement of the problem without any attempt to discuss the steps involved. Perhaps it would have enabled the students to sharpen their skills in solving numerical problems. Moreover, no unsolved problems have been included which may deprive the students in drilling and mastering their skills further.

The language used for the statement of problems and their solutions is simple and direct. Illustrations have been included wherever desirable to support the statement of the problem or the solution. Standard symbols have been used to represent various physical quantities. However, S.I. system of units has not been followed for the data given in some of the problems. Units like dyne (problem 5.1) kgf (problem 2.11) g/cc (problem 10.8). g/cm (problem 10.6), cal (problem 10.46) may create some confusion especially among students who have been exposed only to the S.I. system of units.

In a few problems temperature has been expressed as °k (degree Kelvin) instead of K

(Kelvin) and the gram as gm not as 'g'. In certain problems data has been given in different system of units. The value of constants have not been included in the statement of almost all problems while their substitution have been made in the solution. It may frustrate those students who wish to make an attempt to solve a problem on their own before looking at the solution given in the book.

At times, the statement of the problem is ambiguous and the assumptions made for its solution have not been mentioned explicitly. For example, in problem 1.2, the relative velocity of the two objects moving at right angles with equal velocity (?) has been asked while in the solution it has been assumed that the given velocities are with respect to the earth.

The book does not include multiple choice items which are usually an essential component of almost all question papers set for various entrance examinations. The students preparing for the senior secondary examination may find the book useful while for those preparing for competitive examination it may serve as a reference book.

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